Istituto e Museo di Storia della Scienza, Florence
Opificio delle Pietre Dure, Florence

# The restoration of scientific instruments

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Le Lettere

# INSTRUMENTS OF HISTORY: APPEARANCE AND EVIDENCE

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This paper discusses the issues in the conservation of scientific instruments. The scientists and people from the past cannot speak to us any more, but their instruments can be a source of direct, original evidence about the processes of past discovery and past invention. But if we take these instruments and alter their nature or their appearance, then we put at risk their nature as documents from the past.

As conservation has developed into a professional scientific discipline in its own right, the issues of preserving objects as a source of evidence have been addressed and ways of achieving this have been developed. This is effected more through the development of approaches and attitudes, and the respective roles of curators or owners and conservators, than through technical solutions.

## 1. The development of professional conservation

The discipline of conservation has evolved over a period of time. Restorers have worked on objects, and especially pictures, almost since paintings were first made. But since the 1950s *restoration* has developed into *conservation*: out of a craft approach aimed primarily at improving the appearance and restoring the function of objects has come a profession whose practitioners have to combine a rare mix of skills and knowledge:

- scientific understanding, especially of materials science;
- meticulous scientific observation and recording combined

with an appreciation of the history of the type of object being worked on; and

– high manual skill.

The closest parallel to this is the work of the surgeon, where highly scientific and up-to-date knowledge has to be combined with manual skill and the use of sophisticated new technology.

I would identify the early stimulus for this approach in the emergence of professional archaeological conservation. Here, the principle objective is to preserve objects as part of the scientific evidence for earlier technology and ways of life. Archaeological conservators became highly aware of how much evidence could be found by examining objects themselves. Such evidence might include information as to the method of manufacture, from metallurgy, etc., of wear and use; and of other vanished components or traces of objects that had been buried close by. Objects from archaeological excavations are made from many different materials – metals, glass, ceramic, leather, textile, wood and so on. As well as skill in the almost forensic examination of objects, archaeological conservators had to acquire a broad foundation of knowledge of materials science and the chemistry of deterioration.

Thus was born the unique mix of skills listed above. To teach these skills, training courses were established at degree level. This was a huge leap from the previous approach: of passing on craft skills through apprenticeship. But it became immediately apparent that these skills and knowledge had a general application. They were as useful for the conservation of general museum objects of all kinds as they were for archaeological collections. For some types of object, such as musical instruments, particular specialist skills and knowledge were needed, but the scientific conservation *approach* – that the historic nature of the object should be respected – has spread to these types of object, too, and continues to be adopted more and more widely, by private owners as well as museums.

At the same time, courses in the conservation of paintings and of other conservation disciplines have been established. The context for these courses – universities and technical colleges – immediately had the effect of making the body of knowledge and practice open and shared rather than secret and individual.

## 2. Risks to objects

Conservation is arguably the experience which carries the most risks to the object. Although professional conservation ethics say that the conservator must strive not to do anything to an object that cannot be reversed, in practice this is almost impossible. Drastic conservation measures can seldom be undone.

Conservation can be undertaken for a number of reasons. The work that is likely to take place can dramatically affect the instrument.

### 2.1. *To improve appearance*

First of all, it is a matter of opinion what appearance is desirable. I own a clock made in 1820. The paint on its dial had become wrinkled either through earlier work or through age. A country clock restorer persuaded its previous owner that they could improve the appearance of the dial. The improvement consisted of completely removing all the original paint and repainting it using white gloss enamel. Doubtless the restorer considered they had improved its appearance, but the owner was naturally horrified. Now the dial has been overpainted again in a much more sympathetic manner, but I still miss the soft wrinkled old face that the clock once had.

There are countless examples of objects where what one person perceives to be dirt or disfigurement has been removed, taking with it what seems to another person to be important parts of the object itself. Let us examine some more of these cases.

### 2.2. *To clean the surface*

The surface is part of the object. It is the surface of these objects that often carries the most interesting characteristics and traces of their manufacture and use. Yet it is the surface, above all, that is at risk from the opinions of individuals. Gerard Turner has shown in his work that scientific instruments can embody evidence of their origin and ownership. In many cases, this evidence consists of faint marks, engraved lines and impressions – sometimes overlying each other. Such features are particularly vulnerable to vigorous cleaning.

A good example of this lies in a quadrant in the collection of the Museum of the History of Science in Oxford. Here, two parts of the instrument had become separated and in different ownership – one in the museum's collection, one in private ownership. By chance, the museum purchased the second part, and found to its surprise that the two parts appear to be of the same instrument. Very faint matching scratches and marks on the surface support this view [1].

Another example is to be found in a report of the examination of a Hartman astrolabe by Turner. Turner postulates that Galileo owned it. The argument rests on faint traces of a signature on the back of the instrument, which could easily have been obliterated by vigorous cleaning [2].

Again, cleaning by the unaware can destroy the nature of the object. There is a beautiful example of a 19th-century instrument in the collection of the National Maritime Museum. The metal has a directional grained finish, and where components meet at right angles the graining sharply changes its orientation. Restorers often give instruments a shiny, polished appearance, yet this would destroy a subtle finish like graining. And many maritime instruments had an intentionally non-reflective finish to prevent reflections interfering with sightings.

It is all too easy to remove surface finishes such as lacquers and varnishes, paint or surface decoration or colour. Coloured lacquers were not unknown. Hazel Newey has cited 19th-century recipes for finishes [3]. Any sort of solvent cleaning would remove these. What do we think about simply removing an original part of the object?

Take the case of the astrological signs from the Science Museum's Butcher orrery [4]. Their beautiful paint could not be detected beneath the black corrosion and dirt that overlaid it. This object took the combined skills of a team of conservators – its clockwork mechanism, bent and distorted parts, and the painted finishes each required special expertise. The painted parts were cleaned using sophisticated mixes of solvents applied as gels developed for use in the conservation of oil paintings.

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[1] Jim A. Bennett, «An extraordinary reunion», *Sphaera. The Newsletter of the Museum of the History of Science, Oxford*, 1, Spring 1995, p. 2.

[2] Gerard L'E. Turner, «An astrolabe belonging to Galileo?», *Nuncius. Annali di Storia della Scienza*, XII, 1997, 1, pp. 87-92.

[3] Hazel Newey, *Aspects of the Conservation of Early Scientific Instruments and Apparatii*, dissertation submitted for Diploma in the Conservation and Archaeological Materials, Institute of Archaeology, London, 1976.

[4] Science Museum Accession number 1985-1389.

The obsession with making instruments look shiny had some of its worst effects in the fashion for using a certain proprietary cleaning fluid. This fluid is ammonia based, and ammonia applied to copper alloys causes the rapid propagation of cracks in the metal. Objects can simply disintegrate in due course. Unbelievably, a debate about its virtues raged in the horological press not so many years ago [5].

### 2.3. *Dismantling and reassembly*

Even the seemingly innocent action of dismantling an instrument in order to clean and reassemble it can cause damage.

For example, in removing screws, many people would not appreciate that in scientific instruments each screw was specially made for its hole. The heads may be set at an angle so that they are perfectly flush with the surface, and the screws may vary in length. It is essential to record the position of each one when dismantling an object. The screw slots are often specially shaped. A skilled and knowledgeable conservator will make a screwdriver to exactly fit the screw heads – otherwise the heads can be torn, as they often have been, and the surface of the instrument damaged.

As another example, once a complex instrument is dismantled, unless meticulous records have been kept it may not be easy for it to be reassembled correctly. An instrument in the Museum of the History of Science in Oxford suffered incorrect reassembly.

## 3. Who should decide on treatment?

I have given a number of examples of risks to objects. They are all taken from actual occurrences. In these examples, sometimes the conservator knew best in spite of pressure from the curator or owner, and sometimes the curator knew what would be the best outcome for the long term and the conservator did not. This underlines the need to work as a team, fully acknowledging the skills and knowledge of each person.

Common to all these conservation processes is one fact: the

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[5] Jonathan Betts, «Problems in the conservation of clocks and watches», *The Conservator*, 9, 1985, pp. 36-45.

object cannot be put back into its pre-conservation state. I suggest that both parties should have a power of veto: if an intervention or treatment is *not* performed, there is always the option of doing it later; while if it is done, it normally cannot be undone. The person who advocates *not* performing an action should be allowed to prevail.

## 4. How have these issues been tackled?

There are a number of conservation organisations, and all of them have the objectives of raising understanding of what conservation involves, of promoting higher standards of work, and thus of protecting historic objects from the damaging interventions of amateurs [6]. They all produce guidelines to assist their members and the owners of objects. These conservation organisations include:

*National groups*, for example the United Kingdom Institute for Conservation, and the American Institute for Conservation;

*The International Institute for Conservation*;

*ICOM: the International Council of Museums*. ICOM has specialist conservation groups and groups of curators and others interested in particular collections. For example, CIMCIM, the Committee for Collections of Musical Instruments, has produced guidelines that would be of great interest and relevance to those concerned with scientific instruments, dealing with the issues of objects that are functional.

All their guidelines draw a distinction between *restoration* and *conservation.*

*Restoration*: it is never possible to know for certain what the object was really like, so this is described as the action of restoring to a supposed earlier state.

*Conservation*: preserving what is there and removing the causes of deterioration.

[6] The United Kingdom Institute for Conservation of Historic and Artistic Works (UKIC), 109 The Chandlery, 50 Westminster Bridge Road, London SE1 7QY, United Kingdom; The American Institute for Conservation (AIC), 1717 K Street NW, Suite 301, Washington, DC 20006, USA; The International Council of Museums (ICOM) Secretariat, Maison de l'UNESCO, 1 rue Miollis, F-75732 Paris Cedex 15, France.

Universal principles from all these sets of guidelines are:

– The practitioner must respect the authenticity of the object they are working on: they must not alter its nature.

– There are conflicting demands on the use of objects: the conservator must advocate the course of action that best leads to its preservation.

– The practitioner must not attempt actions that are beyond their skill or facilities. For example if their workshop is not secure, they should not take in high value objects.

– If cost or time is a constraint, then the extent of the work may be limited but not its quality. For example, it might be cheaper to completely immerse an instrument in solvent when really this should be applied on swabs.

– The practitioner must use methods and materials that do not adversely affect future examination, scientific investigation, treatment, or function.

– Everything that is done to an object must be recorded and documented.

## 5. How did these guidelines evolve?

First, conservators became educated not just trained. They learned the scientific knowledge of materials science and chemistry, rather than simply acquiring skills and inheriting knowledge. As knowledge of conservation developed, research began to be undertaken to develop new techniques. New advances were openly published, rather than being kept private as craft secrets.

Conservators began much more to be employed in museums, rather than working privately. They were thus better able to resist pressure to undertake actions that they considered damaging to the object. Improved equipment and premises became available. It can hardly be stressed too much that if one is able to work under a microscope the consequences of one's actions become vividly and immediately apparent.

Ongoing education, attendance at conferences and hence contact with fellow professionals, equipped conservators to engage in debate with curators and other professionals over what was the proper course of action in treating an object.

Finally, employed conservators can see the long-term consequences of their treatments, because they remain familiar with the objects in the collections rather than passsing the objects back to their owners.

Professional guidelines were drawn up by conservators in order to give them backing in these professional debates, and to guide them as to what was the correct professional stance in their work. Apart from CIMCIM (the ICOM Committee for Collections of Musical Instruments), what generally does not exist is a code of practice for owners!

## 6. Issues specific to scientific instruments

There are several issues that are particular to scientific instruments. First, the mix of skills required is very varied, as we saw in the example above, the conservation of the Butcher orrery. This must have been an issue in the original making of these instruments. Makers must have had a very detailed understanding of what the objects were meant to do. It is said that components of different materials were made in different workshops, and assembled in the final place.

The necessary skills and knowledge include:
- knowing about the instrument and function;
- manual skills and an understanding of mechanics and mechanisms;
- materials science and chemistry, so that the conservator is aware of the full range of possible treatments.

Unfortunately, there is only a small market for these specialist conservators, unlike the demand for conservators specialising in pictures, in archaeological objects, or in paper. Furthermore, many important instruments are in private hands. Many owners are not aware of the issues involved in their care. Dealers incline inevitably to take a short-term view.

Finally, there is always debate over how objects that are functional should be preserved. Many people argue that an object is not properly preserved unless it is returned to working order. However, many others argue that a historical object is no longer valued for the function it used to perform, but that it should be kept as nearly as possible in its last viable state, so as to act as a record of what such objects were like. So there are varying perceptions and opinions as to what is the proper course of action.

## 7. Conservation in the Science Museum

As Robert Anderson notes [7], the Science Museum's collections used to be conserved in the large and well-equipped workshops there. The ethos was very much that technical skills should be applied to technical objects like these, the objective generally being to return the object to working order. There was no debate with curators as to possible alternatives, and many curators were very upset about the sort of work carried out on objects in their collections. Others welcomed it.

However, those in the museum were very aware of the sort of issues outlined above. In 1991 Peter Mann, the curator of Land Transport, published an article entitled «Working Objects and the Destruction of Evidence in the Science Museum». Mann thoughtfully reviewed the reasons for the thorough restoration that was the norm, and concluded that this attitude should be questioned. In 1992 the workshops were divided into two groups of people, half being re-designated as conservators, and half continuing as highly skilled museum technicians.

Many of these same technical conservators are still employed in the museum. They have undertaken special training courses designed to equip them with a greater range of possible treatments, and with an awareness of the issues involved in dealing with historic objects. They now work in a well equipped conservation laboratory and technical workshop accommodation, rather than the old traditional workshops. As a final irony, some of the objects that now benefit from these new skills and approach are models or replicas originally made in the workshops!

## 8. Conclusion: Instruments of History

I have discussed some approaches to how objects can be treated in conservation as sources of direct, original evidence about past discovery and invention.

An apt quotation is to be found in a book published by the Getty Foundation [8]:

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[7] This volume, see above, pp. 9-21.

[8] Philip Ward, *The Nature of Conservation: A Race Against Time*, Marina del Rey, CA, Getty Conservation Institute, 1986.

Our heritage is all that we know of ourselves; what we preserve of it, our only record. ... Conservation is the means by which we preserve it. ... It is a commitment not only to the past, but to the future.

## Acknowledgements

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I also gratefully acknowledge the assistance of Hazel Newey, Head of Conservation at the Science Museum, who was one of the first to bring the benefits of a degree in chemistry and training in scientific archaeological conservation to the care of scientific instruments.

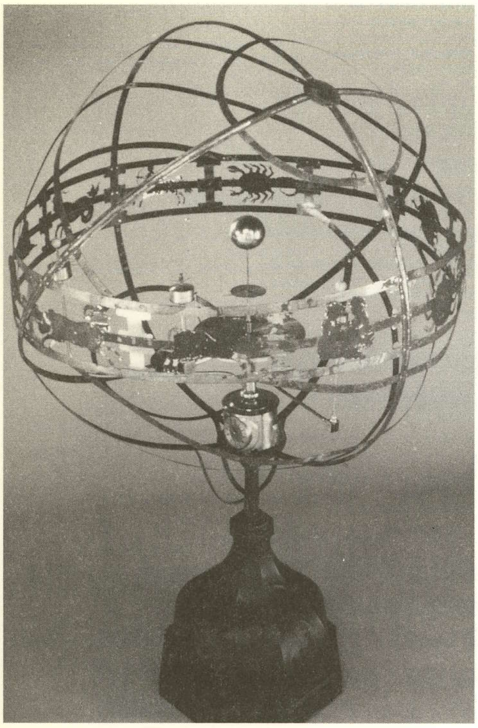

Fig. 1. Orrery made by Charles Butcher *c.* 1733. It is probably the one used by Demainbray to illustrate his lectures on astronomy. It is a highly complex object of which this is a part, in course of conservation. The zodiac figures were disfigured with a thick black layer of concretion.

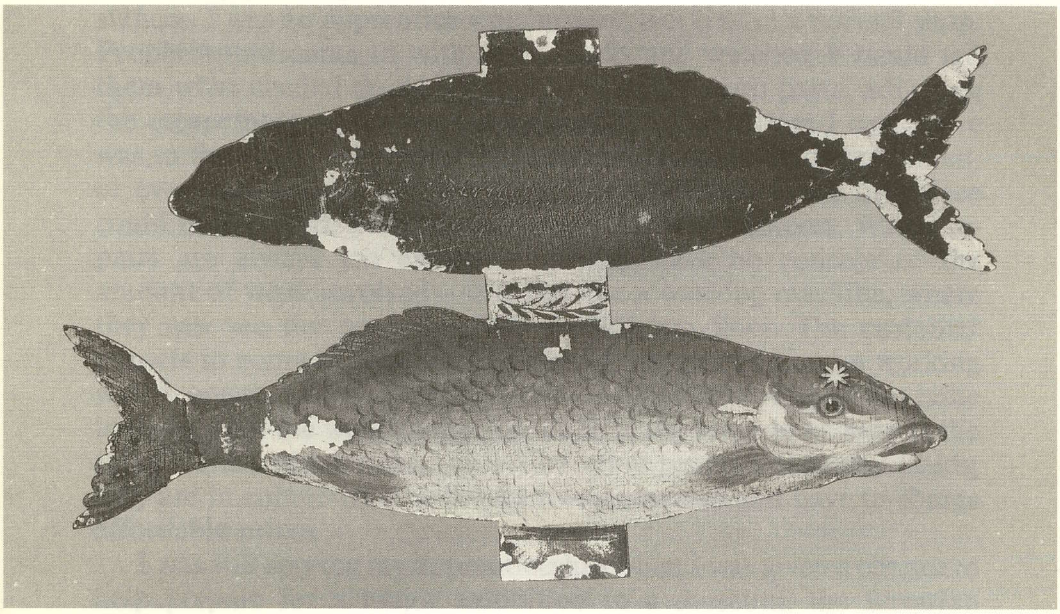

Fig. 2. The zodiac figure for Pisces from the Butcher orrery. By using a sophisticated mixture of solvents of the type often used in picture conservation, the conservator was able to remove the black concretion and reveal the bright, coloured paint (lower fish).