Reconstructing the past: when intangible heritage meets scientific practice

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ABSTRACT

This article argues that during the past decades we have seen a successful embedding of artifacts and practices in the history of science and technology. More recently, concepts of tacit knowledge, gestural knowledge and embodied knowledge have emerged. We have observed in academia and museums a shift from what became called 'material culture' to a more concise approach of a 'maker culture'. This in turn led to history of science and technology museums taking a renewed interest in linking material and immaterial heritage. Historic reconstructions are a powerful method of accessing, examining and combining these various approaches, and the reconstruction method will be discussed here as a historiographic tool, with the intention of bringing historic innovations and community practices together.

Keywords

historic reconstructions, material culture, tacit knowledge, gestural knowledge, scientific practices, history of science and technology, science museums, Karl Friedrich Zöllner, astro-photometer

1. Scientific practice

During the past decades, the history of science and, more recently, technology, has been rewritten as a history of labour. Starting from the history of physical sciences, including astronomy, this approach was extended to areas such as biology and chemistry. Areas where the labour history of science played a significant role were, for example, historic experimentation, historic observations and laboratory fieldwork, where investigating historic practices became essential to understanding the 'making of science'. This included both a history of design practices and a history of uses. Often, these two were different sides of the same coin. Stories of maintenance, mending, repair and recycling add to these multiple dimensions of historic practice. One crucial aspect of historic practices is the role of artifacts in the making of science, for example, a historic

microscope was designed and used to view micro-organisms, and an air pump to produce a vacuum. Manifold histories have originated from this approach, from the history of experimental practices to the history of laboratory cultures. New historiographic concepts were introduced, such as the role of the body in historic experimentation, so-called 'gestural knowledge', the learned or trained 'muscle' knowledge needed to carry out experiments or operate machines.

One of the decisive studies here was, for example, Peter Heering's work on historic solar microscopes. Solar microscopes are demonstration devices that were particularly popular during the second half of the eighteenth century. Through practising with actual instruments, it became possible for Peter Heering to develop an understanding of the experimental culture related to the solar microscope and of the technical development of the instrument. Here, aspects such as user-friendliness seem to have played an important role, and several of the practical skills of the demonstrator were found to have been embodied into the device [Boon, Kneebone, Heering, Staubermann and Winkin: 2017] (Plate 1).

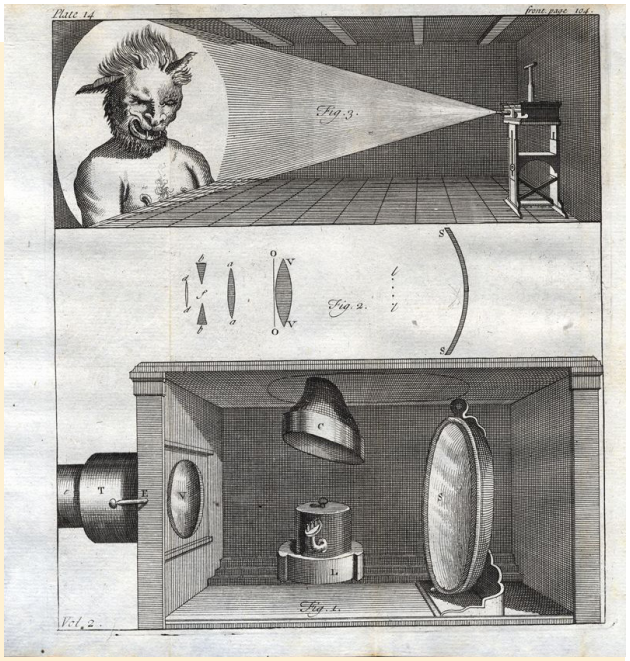


Plate 1
It was the absence of practitioners in scientific illustrations, like this one of a magic lantern projection by the Dutch inventor, Willem Jakob 's Gravesande, originally published in 1731, that made historians of science and technology more aware of historic practices. 1747 edition. Photo: Tiemen Cocquyt / Klaus Staubermann, 2011.

In my own work on the history of astronomy, I studied a nineteenth-century astro-photometer designed by the Berlin physicist, Karl Friedrich Zöllner, Germany's first professor of astro-physics. My work demonstrated how historic observers interacted with new designs and how different practitioners who used new types of instruments could reach agreement on their visual experiences. Through using a reconstruction of the photometer, which I will discuss later in this article, I explored how doing this provided me with a new and deeper understanding of the skills, practices and tacit knowledge involved in the making of nineteenth century astronomical photometry [Staubermann: 2007].

It was the introduction of concepts of historic practice that enabled scientists to make a meaningful connection with historic artifacts in science and technology, and thereby tapped into previously unused historic resources. In consequence, museum collections became essential tools for research in the history of science and technology. Whereas previously, students and scholars in the history of science and technology would work in archives, libraries and record offices, they can now be found working in museums [Seidl, Steinheimer and Weber: 2018]. Curators and scholars formed meaningful and productive relationships leading to new types of scholarly collaboration and projects. These emerging relationships did not end with the publication of articles and books, but were also reflected in new types of displays, exhibitions and public engagement.

New types of public engagement in science and technology museums in turn stimulated a broader interest in the making of science and technology, something which benefited these museums immensely. These new insights informed, for example, collecting policies. Whereas in the past, science and technology museums would have collected stand-alone artifacts such as an astronomical telescope, they began to collect contextual or peripheral items such as lens-making equipment, a brass-maker's lathe, an observer's chair or a spare set of eyepieces. All this 'paraphernalia' embodied the practical exchange between the human and the artifact.

Examining historic scientific practices also meant a shift from simply studying the user of scientific equipment - the scientific practitioner - to including the maker of the equipment. Today, scientific practitioners and instrument-makers are often seen as equals. It also

meant dissolving the traditional boundaries between sciences, crafts and arts. Dutch renaissance painting serves as an example here, where painters composed pictures and produced paints but also employed optical instruments such as *camerae obscurae* to achieve increased realism.

This research into practices triggered a growing interest in broader concepts of practice. The role of gestural or mechanical skills and knowledge were part of this new interest, and so were studies of visual practices, for example, in the context of magic lantern shows, visual entertainment and early cinema, but also in studies of sound and taste. A concept that was introduced by the philosopher Michael Polanyi and soon became adopted by many scholars was 'tacit knowledge' [Polanyi: 1958 and 1962]. Tacit knowledge is knowledge that is, or can be, difficult to communicate because of its ubiquitous or embodied nature, for example, like riding a bike.

Such knowledge is transferred from designers, to users, but also into museums, and further to audiences and the public. Tacit knowledge is easily overlooked and often not recorded, and includes hidden techniques relating to the various senses, such as touch, sight, smell or sound. It can only be acquired through participation in processes and practices. Understanding historic tacit knowledge enables us to gain a deeper and new understanding of museum artifacts and the cultures in which these artifacts originated and of which they formed a part.

Introducing questions of tacit knowledge into the history of science and technology, such as how to operate a telescope in the dark, can add new and exciting dimensions to capturing, interpreting and writing history. What skills, knowledge and training does it take to use a camera, drive a car or dissect an animal, for example? It was questions like these that demonstrated how the focus had shifted to the knowledge embodied in both the practitioner and the artifact.

2. Intangible heritage

Since the ratification of the *Convention for the Safeguarding of the Intangible Cultural Heritage* by UNESCO, intangible cultural heritage has become an integral part of many museums. From best practice examples to projects such as ICOM's 'Intangible Cultural Heritage and Museums' there is now a wealth of innovative initiatives around the world.

Whereas museums dedicated to historic craftsmanship, such as ethnographical or open air museums, found it relatively easy to implement concepts and programmes of historic practices, other types of museums followed suit more reluctantly. Multiple types of intangible heritage that can be found in museums have been listed over the past years, ranging from artisan techniques, such as glass making, to technologies such as Morse telegraphy [Wissen: 2017].

The UNESCO *Convention for the Safeguarding of the Intangible Cultural Heritage* explicitly refers to the *deep interdependence between the intangible cultural heritage and the material cultural and natural heritage* [UNESCO: 2003]. Nonetheless, in many museums these two substantive aspects of cultural heritage still seem to exist independently, on the one hand in the shape of established object research and on the other hand in ever-new initiatives on intangible cultural heritage.

Whereas academic studies in the history of the science of technology mainly took their stories from artifacts found in existing collections, museums are now faced with an additional challenge: how to manage the complex and challenging process of collecting



Plate 2
Intangible heritage in museums has a strong focus on capturing, preserving and sharing communal practices, such as Scottish weaving at Paisley Museums.
Photo: Klaus Staubermann, 2013.

both tangible and intangible heritage. This is why it is essential to develop new epistemological approaches to connect tangible and intangible cultural heritage in museums, and to re-interpret existing connections and make them accessible to museums and their audiences [Umfrage: 2017].[1] (Plate 2).

Moreover, communities often do not want their craft or technologies to be perceived as 'heritage' by museums as they think this might undermine innovation processes, for example, in textile making. Alternatively, craft or technology businesses themselves may decide to turn their products into heritage, for instance, to enhance their cultural and economic status. This can be observed by active businesses that run shops or outlets, but also by museums that have their own production facilities. These businesses are keen to keep innovation processes alive [Mamadipudi: 2018]. Indeed, once production is disconnected from innovation processes it runs the risk of becoming sterile and dead. A crucial element of intangible heritage practices, skills and knowledge is their constant renewal or evolution.

This is why museums need to develop strategies to better understand innovation processes within tangible and intangible culture. These in turn can inform us about how museums and connected communities can keep tangible and intangible heritage alive. Here, intangible heritage studies can benefit from recent work in the history of science and technology, especially in the museum context. As I will outline below, these studies of historic science and technology practices can help us to better understand historic innovation processes.

3. Historic practices

Let us examine some of the historiographic tools that have been developed by historians of science and technology that can help us to better understand the relevance of historic practices, skills and tacit knowledge for tangible and intangible heritage.

The task of historians and curators of history of technology alike is to recreate the contexts that led to the manufacture of artifacts, usually by means of archives, collections, and where possible, historic witnesses. Order books or trade catalogues can be of help, too, as these tend to emphasise what was or is unique or special about an artifact. Witnesses are of particular interest to historians as they hold and can share historic knowledge that otherwise might have been lost.

Of particular interest to historians of the science of technology are the environmental conditions in which artifacts were manufactured, as they can influence and determine the outcome of an experiment or affect the quality of a piece of work. To give just one example, certain types of clothing can have an effect on the outcome of an electrostatic scientific experiment or cause risks when operating a machine.

Another key aspect of making sense of science and technology artifacts are the multiple parts, accessories and spares that act as interfaces between the person and the artifact. In order to render an artifact ready for use it needs to be adapted and re-engineered. This history of the adaptation of artifacts for local usage does not end with their development from design to use. Artifacts get re-designed or re-invented by their users, often several times over. The history of adaptation, maintenance and repair takes the artifact on a journey, sometimes over several generations and through several cultures. This must be considered as a global history of materials and practices. (Plate 3).

Tacit knowledge in the history of science and technology can be difficult to capture and communicate, such as working with sound in the manufacturing



Plate 3
Keeping historic practices alive, such as the operation of a 1906 Marshall traction engine, is one of the challenges historians and curators of science and technology face.
Photo: National Museums of Scotland, 2010.

process. Here, sound can tell the machine operator many things, for instance if the material is too hard, the tool wrongly positioned or the speed of the machine too high. Sensing temperature is another non-verbal skill and crucial for operating a machine. Some of these skills might be passed from master to apprentice and others come from experience on the work floor. This knowledge, even if it can be communicated, is usually acquired during the work process.

But how can we capture this tacit knowledge? How can we understand it within its historic context and learn from it for the future? How do we capture the practices, skills and techniques that enable us to understand the making and uses of artifacts? And how do we keep these practices alive, especially when they become part of the (non-intangible) documentation in the museum?[2]

A significant and powerful historiographic tool that has been developed by historians of science and technology, and adopted by science and technology museums over the years, is the reconstruction of the making and uses of artifacts. I will outline this approach and method in the next section.

4. Reconstructions

Over the past few decades historic reconstructions have become a decisive tool in the history of science and technology. They cover subject areas as diverse as physics, computing, horology, communication, transport and the military. These reconstruction projects have provided historians and curators with a new or deeper understanding of the skills, practices and tacit knowledge involved in the making and use of material culture. They analyse, for example, competing traditions in the manufacture and use of artifacts and reflect on the changing social roles of users and inventors. They cover questions such as, what can we learn from placing practices in a broader cultural context, or what are the uses of 'failed' inventions? (Plate 4).

Employing reconstructions is not a recent development. Experimental archaeology is perhaps the discipline with most experience in reconstructing historic artifacts and practices. From the nineteenth century onwards archaeologists attempted to recreate the techniques and crafts of the past. Also, the first literature raising methodological questions was produced in this discipline. By linking archaeology and anthropology during the past decades, reconstruction projects have taken on an increasingly social and community dimension.

Until the second half of the twentieth century, maritime history was the most publicly visible area for historic

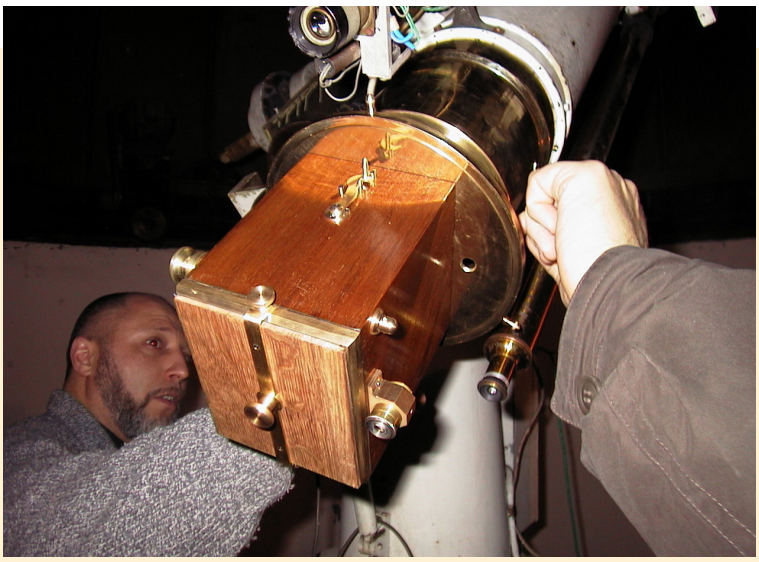


Plate 4
Reconstructing historic artifacts, such as this nineteenth century astro-photographic camera by Oswald Lohse, and associated practices in Sofia, Bulgaria, can provide us with essential information about their technical and social role at the time.
Photo: Klaus Staubermann, 2001.

reconstructions. Boats of all sizes and periods, from canoes to submarines, were reconstructed. Moreover, impressive journeys on these vessels were undertaken in order to better understand historic craftsmanship, navigation, and exploration. Although this work is to a large extent the outcome of experimental archaeology, it is now regarded as a discipline in its own right.

One such high-profile project was the reconstruction of the 'Sea Stallion from Glendalough', a Skuldelev 2, 30-metre-long Viking warship. The ship is the tangible result of a reconstruction process, where the considerations and reflections concerned practical solutions, workmanship, the properties of materials and the consumption of resources. The reconstruction included sailing 'Sea Stallion' from Denmark to Dublin and back in rough weather. Building and sailing the ship not only provided historians with detailed knowledge about the construction and handling of long ships, it also gave them a new insight into the community practices of the Viking period.

To return to reconstructions in the history of science; during the past forty years these have become a well-established historiographic tool. Starting from the experience of replicating historic instruments for educational purposes, to reflections about the general replicability of scientific experiments, reconstructions of historic scientific instruments and experiments have become a corner stone of this discipline today [Staubermann: 2011].

One outcome of the reconstruction method is the insight that understanding historic artifacts is impossible without understanding the practices associated with, or embodied in them. Some philosophers of science have pointed out that the question if and how historic skills can be uncovered by interaction with the artifact is one of the most challenging in the history of science and related disciplines. The many case studies of the past decades have helped to shed some light on the relationship of reconstructed artifacts and the historic practices embedded in them.[3]

Of course, there is a much wider hermeneutic dimension to historic reconstructions. This ranges from questions such as how to situate material reconstructions in the broader context of reconstructing the past through historic records, to how to recreate immaterial tools such as thoughts, choices or motives. Key debates during the past decades, as I pointed out earlier, examined the role of tacit knowledge and personal skills in the making and use of artifacts. As a result, discussions about knowledge building and skill transfer are now at the heart of museums' activities.

5. A case study

Although many of the reconstruction projects that have been carried out during the past decades differ significantly in period, location and type of artifact, the approaches taken have followed a similar method. This method includes the examination of existing artifacts (materials, designs and function) and records, the construction of the replica, its use, and the interpretation of the experiences gained. This enables us to learn about the functioning, manufacturing and uses of a historic device, machine or instrument. Maintenance and repair, as I pointed out earlier, is another crucial aspect that needs addressing. It is this design, manufacture, use, maintenance and repair of the artifacts that helps us to understand their role and significance in the past. Thereby, reconstructions become probes into historic skills, practices and cultures.

My reconstruction of the astro-photometer made by the young physicist, Karl Friedrich Zöllner, in Berlin might serve as an illustration here: in the process of replicating the instrument I questioned every part of it. Questioning the functioning of every part of the instrument was essential for putting it into practice. This would have been different for a user who was not accustomed to the functioning and modes of practice of the photometer. Rebuilding Zöllner's astro-photometer (a photometer that measures the brightness of stars) and redoing his astronomical observations, was crucial for the understanding of his observational practice. Reworking Zöllner's photometry also helped me to explain how and why Zöllner approached the night sky the way he did and, moreover, how to situate his practice technically and socially.

Before I replicated the photometer I perceived it, like many historians before me, merely as an astronomical instrument, and focused on features such as optics and lenses. It was practising with the instrument that changed my perspective as a historian. Considering what caused 'trouble' while building the replica of the photometer and



Plate 5
The reconstruction of historic artifacts and the re-enactment of historic practices enables us to better explore and understand historic innovation processes and keep them alive.
Here, the author practises with the reconstruction of a nineteenth century astro-photometer invented by Karl Friedrich Zöllner in Berlin.
Photo: Marina Frasca-Spada, 1996.

practising with it, my focus changed from the 'telescopic' or astronomical features of the device to the features connected with creating the artificial comparison image, such as controlling the gas flame for producing it. The telescopic lens, considered at first to be the most important part of the photometer, turned out to be of only limited historic significance. By practising with the photometer my experience turned from an astronomical observation into a laboratory experiment: operating in the dark, keeping the instrument dry from condensation, but also keeping awake at night and putting on hold my social night life.[4] (Plate 5).

This can be considered the most important insight gained during the reconstruction process. Zöllner, during most of the twentieth century, had been perceived as an astronomer because of his contributions to astro-photometry and his career in astro-physics. Rebuilding Zöllner's photometer and redoing his observations changed this perception. Both Zöllner's observational practice and his instrument originate from an industrial laboratory background. It was his family background in the dyeing business and his interest in industrial light and colour measurements that drove him to designing new types of instruments. The polarimeter, an integral part of Zöllner's photometer, was an established laboratory device at this time and was widely used in universities and, moreover, in emerging and established nineteenth century industries. Zöllner's achievement was to engineer a device that could be moved out of the laboratory and under the night sky and generate standardised photometric measurements of the stars.

The story of Zöllner's photometer must be considered as part of a broader narrative which took place in Germany and elsewhere during the second part of the nineteenth century: laboratory researchers designing specialised instruments for both industrial and academic uses. [Herrmann and Hoffmann: 1976] Although these instruments were designed for highly specific purposes, their design was flexible enough to respond to a wide range of applications and environments [Shinn: 2001]. What these new types of instruments had in common was their intended use for standardisation and control, both in science and in industry. As the polarimeter had helped chemists and dyers to standardise and control colour production and manufacturing processes, it also helped to standardise astronomical measurements and performance.

This detailed account is intended to illustrate that by examining historic practices through reconstructions

we can achieve a change of historiographic perspective and gain a deeper understanding of both history and innovation. Whereas previously, historians of science and technology chose a 'top-down' approach, from scientific theory or technological concept to experiment and design, we can now argue differently. This change of perspective enables us to argue through social practices and craftsmanship towards a more conceptual understanding of innovative processes in the making of science and technology and, more broadly, intangible heritage in museums.

Conclusion

Historians, curators and museums have become increasingly aware of the potential of understanding historic practices, craftsmanship and innovation processes through reconstructions. Several museum projects are now under way globally [Borgmann: 2018]. The reconstruction of historic processes as a research method can help museums to combine the 'top-down' approach favoured by historians in the past, and a 'bottom-up' approach that promotes community activities. Moreover, it enables us to redefine approaches to intangible heritage that in the past often sidelined museums and collections; we can now bring together both historic understanding and past and future innovation processes. To both preserve and keep alive museum artifacts and practices must be at the core of any successful intangible heritage work in museums. Reconstructions can help us to achieve this.

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ENDNOTES

1 It is worth emphasising again that, according to UNESCO, instruments, objects, artifacts and cultural spaces form an integral part of the concept of intangible heritage.

2 *Wenn immaterielles Kulturerbe auf die ein oder andere Weise als materielle Dokumentation in eine Museumssammlung Eingang findet, wie kann dann der Lebendigkeit von immateriellem Kulturerbe Rechnung getragen werden?*
(English translation: 'If, in one way or another, intangible cultural heritage finds its way into a museum collection as material documentation, then how can the liveliness of intangible cultural heritage be taken into account?' [Schühle: 2019]

3 Do we want to 'retire' objects for preservation reasons or keep them 'alive'? This does not need to be a contradiction: it is not always desirable to retire a museum artifact, especially if it is intended to re-animate the artifact at a later point in time, for example, boats, clocks or musical instruments.

4 Note that studies of astronomical practices and instruments bring together two domains of the UNESCO 2003 *Convention* that are often perceived separately: practices that concern nature and the universe and practices that concern traditional craftsmanship.

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