History and Sociology of Science

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Abstract

The relationship between archaeology and other sciences has only recently become a research topic for sociologists and historians of science. From the 1950s to the present day, different approaches have been taken and the aims of research studies have changed considerably. Besides methodological textbooks, which aim at advancing archaeological knowledge, historians of archaeology have tackled this question by exploring the development of archaeology as a scientific discipline. More recently, collaborations between archaeologists and other scientists have been examined as a general phenomenon regarding transfers of knowledge and power relationships between specialists, organizations, and scientific tools, where archaeology is considered as a scientific practice. Adopting a socio-historical perspective, this entry examines the specificity of aims, facts, and procedures shared by archaeologists and other scientists regarding the crucial question of measuring time and computations.

Keywords: archives; controversy; historiography; history; history of archaeology; interdisciplinarity; reflexivity; social history of science; social studies of science; sociology

Archaeology and sciences or archaeology as science?

From the late nineteenth to the early twentieth century, human and natural sciences were gradually reorganized into institutionalized forms. The diversification of research trends in archaeology, a trend also observed in other sciences, led to a number of ways to refer to the natural sciences, which ranged from using them as a model of scientificity to defining the difference between them and the human sciences. Local histories of scientific institutions, research traditions, and political and personal choices alike influenced the position of archaeology within the scientific field—a position that could be closer to or more distant from the human and natural sciences. The case of prehistoric archaeology highlights this crossing over of branches in the classification of sciences. The development of prehistory as a scientific practice in the second half of the nineteenth century relied on a wide range of approaches, including ethnography, history, physical anthropology, paleontology, geology, and botany, from which prehistory borrowed methodological and conceptual tools. In the nineteenth century, archaeology (see ARCHAEOLOGY) and prehistoric archaeology were part of a large research field that encompassed geography, physical anthropology, linguistics, and ethnography and aimed to describe and understand human history from natural and cultural perspectives (Blanckaert 2000). Consequently there is an intrinsic relationship between *archaeology* and *science*: the aim of producing archaeological knowledge is *in itself* a scientific project, and it is preferable to talk about the relationships between archaeology and other sciences.

The term "archaeosciences" is loaded with the same content: if a part of archaeological practice is scientific (the "archaeosciences"; see ARCHAEOLOGICAL SCIENCES), what about the other part? The role of historians and sociologists of science is not to find the best solution to this problem, but rather to investigate the variations in the definitions of these terms. An important issue is to identify the relationship (in terms of epistemic and social dimensions) between archaeological practices and practices in the sciences applied to archaeology—in other words, to explore the diachronic and synchronic variations in the ways archaeology has been grounded as a scientific enterprise and the controversies surrounding this topic. Indeed, the concept of archaeoscience has its own history and is closely related to the concept of archaeometry (see ARCHAEOMETRY).

A brief examination of the evolution of the latter can clarify the relationship between archaeology and other sciences. It is important to understand the meaning of *-metry* in archaeometry. The term started to become popular in the 1960s, and in 1961 the first "Symposium on Archaeometry" was held in London; it was an annual meeting that focused on the applications of physical science in archaeology. The growth of archaeometry increased rapidly in the mid-1970s. From 1975 onward, the location of the symposium changed every year; the symposium itself became international and renamed "International Symposium on Archaeometry and Archaeological Prospection." This internationalization was also reflected in the creation of the *PACT* group in 1976, by the Council of Europe. This group was defined as a European study group dedicated to the study of physical, chemical, biological, and mathematical techniques applied to archaeology. From 1977 on, this group published its own journal, the eponymous *PACT*; at the same time, in 1976 the *Groupe des méthodes physiques et chimiques de l'archéologie* (GMPCA) was founded in France in 1976 and started issuing its own journal, *Revue d'archéométrie*, one year later. These three cases illustrate different definitions of archaeometry: in the UK symposia and in the

French GMPCA, mathematics was included only insofar as it provided methods to process the results of physical and chemical measurements; on the contrary, in the European PACT group, mathematics was an integral part of the group's definition.

The concept of measurement is relevant to the measurement of abstract properties in mathematical objects and of concrete properties in physical objects. From the 1970s onward, however, archaeometry was concerned mainly with the measurement of concrete properties; it excluded mathematics and restricted itself to physical and chemical procedures designed to investigate archaeological facts. This evolution was also related to the professionalization of archaeology, the growth of archaeometry as a specialized field, and the redefinition of the relationships between archaeologists, mathematicians, physicists, and chemists. The extensive scope and multidisciplinary nature of archaeometry and of the archaeosciences illustrate the inadequacy of an analysis based only on a normative classification of the sciences and the relevance of a socio-historical inquiry on this issue.

The first section of this entry focuses on the different approaches taken by authors who assess the relationship between archaeology and other sciences from social and historical perspectives, and on the evolution of these approaches. The evolution of these authors' aims is also examined. The second section focuses on a long-term perspective. Since the nineteenth century, archaeological research has integrated a range of aims, facts, and procedures borrowed from or shared with other scientific disciplines.

Scientific transfers and applications in archaeology: an overview of social and historical approaches

During the twentieth and twenty-first centuries, the position that authors occupied in their discipline and the nature of their work on the history of the relationship between archaeology and other sciences can be classified into three main categories. A first group is formed by internalists: archaeologists who construct the history of their own discipline and practices, and aim to advance archaeological knowledge. The second group is formed by archaeologists who are concerned with the history of their discipline as a social practice (see scientific practice). The third group consists of externalists: historical and sociological analyses of the relationships between archaeology and other sciences are produced by historians, sociologists, or ethnologists positioned outside the field of archaeology. They aim to advance the knowledge of general phenomena related to past and present activities based on the case of archaeology.

Progress in archaeology: archaeology's relationships with other sciences

From the first decades of the twentieth century to the present day, many archaeologists have published reviews or methodological textbooks that aim to describe the diversity of tools available from the natural and formal sciences, as well as their limitations in archaeology. These contributions, assessing the relationship between archaeology and other sciences, aimed to strengthen the archaeological discipline and to support the research of archaeologists. In addition, they were conceived as a means of exposing the progress of the discipline, since they coincided with the first attempts at professionalizing prehistory (in the 1920s) and with the development of technical tools in physics, chemistry (see CHEMISTRY IN ARCHAEOLOGY), and isotope (see ISOTOPES) research (in the 1950s). An emblematic contribution is Annette Laming's book *The Discovery of the Past: Recent Progress and Techniques in Prehistory and Archaeology* (published in French; see Laming-Emperaire 1952).

Archaeologists examining their discipline as sociologists or historians

Since the 1990s, the relationship between archaeology and other sciences has been investigated by archaeologists influenced by or aware of approaches developed in cultural and social history and in the history of science. Examining the institutions, the actors, and their practices, these authors have tackled the relationship between archaeology and other sciences within the context of formation and development of archaeology as a scientific discipline (Hurel and Coye 2011; Kaeser 2011). More recently, this relationship has been approached from the point of view of the development of specific tools and methods (e.g., 14C dating, dendrochronology, fluorine) that involve archaeology and natural and formal sciences, in a context of strong disciplinary affirmation (Delley 2015). Such researches focus on the behavior of the scientists and assess their actions in complex social interactions (e.g., power relations between disciplines and institutions, the role of politics in science, the relation between science and the army, medicine, culture). The use of archives, the contextualization of observations, as well as the historicization of the categories commonly used in archaeology (e.g., dating, modernity, interdisciplinarity, amateur, professional: Plutniak 2017) are constitutive of this approach, which is recognized either as a component of archaeology or as a part of the history of science.

Archaeology as a case study for social studies of science

Since the 1940s and following the pioneering work of Robert Merton, social and historical studies of science grew in number and were empirical investigations of various disciplines. Until the present day, however, archaeology has rarely been investigated by sociologists or science historians. In fact, social studies of sciences have focused mainly on natural, formal, and experimental sciences; one explanation is that archaeology is a newer discipline by comparison to physics, mathematics, or physiology. Nevertheless, there are some studies that have addressed sociological questions regarding the relationship between archaeology and other sciences. An example is the sociology of expertise developed in Bessy et al. 1993. This work investigates the case of Glozel, an alleged forgery site, and shows how arguments grounded on the use of radiocarbon (see RADIOCARBON CALIBRATION AND AGE ESTIMATION) and thermoluminescence (see DATING CERAMICS AND LUMINESCENCE) can be controversial. The sociolinguistic approach is another example (Goodwin 2000). Dealing with ethnomethodological questions related to 3 the role of vision (or visual experience) in the analysis of situated practices, Goodwin analyzed how archaeologists decide the description and colors of a stratigraphy. During the 1990s, the influence of postprocessual archaeology and its particular relation to ethnography and reflexivity (see SYMMETRICAL ARCHAEOLOGY) blurred the frontier between archaeologists analyzing their own discipline and sociologists or historians examining archaeology as a case study. An example is the collective book on the ethnography of archaeology (see ETHNOGRAPHY AND QUALITATIVE METHODS IN THE FIELD) edited by Edgeworth, an archaeologist, which collects papers from archaeologists, sociologists, curators and linguists (Edgeworth 2006).

The relationships between archaeology and other sciences: examining time

The relationship between archaeology and other sciences encompasses a wide range of scientific practices and relationship modes, for example transfer of concepts (by analogy or metaphor), methods (devices or skills), or knowledge aims. To give a short but broad example, this section focuses on the case of examining time (see TIME AND TEMPORALITY) by distinguishing three main categories of scientific methods of inquiry: observing (the effects of time), measuring (the effects of time), and computing (temporal data).

Observing the effects of time

Since the second half of the nineteenth century, observing the effect of time has been a central question in prehistory. Archaeologists expected the natural and formal sciences to devise methods to resolve this issue, in addition to the usual tools of classification (see ARCHAEOLOGICAL CLASSIFICATION) of artifacts and stratigraphy. In the early nineteenth century, the paleontologist Georges Cuvier and the mineralogist Alexandre Brongniart defined a methodological tool where faunal characterizations were used to establish a relative chronology between different stratigraphical layers. A few decades later, a scheme for recognizing and characterizing the successive stages of the development of material culture was established by Christian Jürgensen Thomsen and Jens Jakob Asmussen Worsaae on the basis of the collections stored at the National Museum of Copenhagen. Named the "three-age system," this conceptual tool relies on the morphological and technological analysis of archaeological material. The composition of this material (stone, bronze, or iron) establishes a division of time. In the 1840s the demonstration of the antiquity of "man" by Jacques Boucher de Perthes was built on naturalist and cultural principles involving paleontological, geological, anthropological, and cultural observations (see MATERIAL CULTURE) and established the first elements of what would become the scientific practice called prehistory. At the same time, in Denmark, a commission of experts composed of archaeologists and naturalists explored the famous kitchen midden (*kjoekkenmoedding*), whose chronological attribution was highly problematic. Around the 1870s, Gabriel de Mortillet used in his classification of prehistoric industries paleontological stratigraphy and the "three-age system." Naturalist and cultural conceptions are built using evolution theory, which is based on geological and paleontological evidence applied to the morphological classification of human artifacts (Hurel and Coye 2011).

Since the late nineteenth century, wetland zones—marshes, bogs, and lakeshores where organic remains are particularly well preserved—have been locations of intense exchanges between naturalists and archaeologists. During the first half of the twentieth century, these collaborations took institutionalized forms with the creation of laboratories and institutes in Tübingen, Groningen, and Basel that aimed at including botany and palynology—besides sedimentology, paleontology, and material culture—in the practice of archaeology. The history of vegetation and climate (see CLIMATE CHANGE AND DATING), combined with the fine analysis of stratigraphies and artifact typologies, stems from the same preoccupation of observing the effect of time from a natural and cultural perspective.

Measuring the effects of time

The introduction of measurement in archaeology was an important methodological and epistemological step (see MEASUREMENT THEORY); furthermore, it also divided actors according to whether they could perform the method in question or not. These measurements concerned mainly the properties of cultural artifacts and organic and physical facts to the extent that they could reveal the effects of time.

A first case is the measurement of cultural assemblage properties. An example is the early development in seriation (see SERIATION methods), introduced by Flinders Petrie in the late nineteenth century. Petrie also authored one of the first extensive applications of mathematics to archaeological facts in his book *Inductive Metrology*, published in 1877. Seriation methods consider a set of objects and measure the properties of each (for instance types of potteries).

The variations observed in the targeted set lead the observer to infer the relative chronology of these objects. American archaeologists largely adopted and improved statistic-based seriation methods (see DESCRIPTIVE STATISTICS), notably in the work done in the 1910s in the Pueblo and Zuni regions by researchers such as Alfred Kidder, Alfred Louis Kroeber, and Clark Wissler, who integrated these methods within an evolutionary (see EVOLUTIONARY THEORIES) framework (see Lyman and O'Brien 2006).

Dendrochronology, which was introduced into Europe by Ebba Hult de Geer and Bruno Huber during the 1930s and 1940s, in botany (see CHARCOAL AND WOOD ANALYSIS), is at the frontier of observing the effect of time and measuring it. Dendrochronological curves can be built, and thus historical sites dated, by comparing and correlating the patterns of tree rings. The use of this method in dating prehistoric settlements was limited to establishing (although very precisely) relative chronologies until the 1980s.

Since the 1950s, radiocarbon dating has been considered, in textbooks on method, the emblematic example of a collaboration between archaeology and other sciences. This tool, developed shortly after World War II, determines the age of an object by measuring its radioactive decay. Analyses are performed in physical laboratories disconnected from the archaeological milieu. In addition, the tool was quickly presented as being "under control" by laboratories, which expected a direct correlation between the 14C decay curve and the calendar time curve. This assumption relied on the false hypothesis that the production of 14C was constant through time. Statistical and computational methods of calibration (see RADIOCARBON CALIBRATION AND AGE ESTIMATION) were developed to solve this problem of the fluctuating 14C production in the atmosphere.

Time computation

During the second half of the twentieth century electronic computers became more powerful. This advancement led to redefinitions of previous methods: the research problems might have been the same, but the methods used to solve them radically changed, as computational complexity became less of a limitation (see COMPUTER APPLICATIONS IN ARCHAEOLOGY). The main difference was that calculations were not made on the observed properties of archaeological facts, but directly on calendar data integrated into an abstract statistical time model. A shift occurred from dealing with representations of temporal effects to dealing with representations of time, which allowed for the integration of multiple dating sources in the same formal framework. Regarding the development of dendrochronology in Europe, where climatic signals are weaker than in southwest America (where the tool was first developed by Andrew Ellicott Douglass), local dendrochronological curves can be inserted in a long referential curve, which connects the present day to prehistoric times and provides archaeologists with an absolute dating tool that necessitates the use of statistic computations. Physicians and statisticians developed Bayesian (see

BAYESIAN STATISTICS) frameworks that allowed the calibration of unique datings and the integration and correlation of multiple dating sources (radiocarbon, dendrochronology, thermoluminescence). From the 1970s on, an important chronometer was developed on the basis of ancient DNA (see GENETICS: ANCIENT and GENOMICS: ANCIENT) and of the known mutation rate of biological molecules. The "molecular clock" hypothesis and method offered a new way to estimate time in prehistoric archaeology. Both DNA sequencing (see DNA: NEXT GENERATION SEQUENCING) and the calibration of the relative duration provided by the molecular clock rely on computational techniques.

In fact, the difference between observing and measuring the effects of time on the one hand and analyzing temporal data on the other is not only a matter of methods or concepts. The introduction of new methods to investigate time in archaeology also redesigned the organization and practices of archaeology, modified its boundaries, defined new powers and relationships between archaeologists and specialists in other disciplines, and changed the image of archaeology in society. Archaeosciences and archaeometry have for instance connected archaeology with the iconic place of modern science: the laboratory (Delley 2015). These aspects are empirically investigated by social scientists and historians.

References

Bessy, Christian, Francis Chateauraynaud, and Pierre Lagrange [1993], "Une collection inqualifiable. La controverse sur l'authenticité de Glozel," *Ethnologie française*, 23, 3: *Science / Parascience : Preuves et épreuves*, p. 399-428.

Blanckaert, Claude [2000], "1800 – Le moment 'naturaliste' des sciences de l'homme," *Revue d'Histoire des Sciences Humaines*, 3, 2, p. 117-160, DOI: 10.3917/rhsh.003.0117.

Delley, Géraldine [2015], *Au-delà des chronologies. Des origines du radiocarbone et de la dendrochronologie à leur intégration dans les recherches lacustres suisses*, Archéologie neuchâteloise, Neuchâtel: Office du patrimoine et de l'archéologie de Neuchâtel, section archéologie, vol. 53, 273 pp.

Edgeworth, Matt [2006], *Ethnographies of Archaeological Practice. Cultural Encounters, Material Transformations*, Lanham (M.d.): AltaMira Press, xviii–195 p.

Goodwin, Charles [2000], "Practices of Seeing. Visual Analysis: an Ethnomethodological Approach," in *Handbook of Visual Analysis*, ed. by Theo van Leeuwen and Carey Jewitt, London: Sage Publications, p. 157-182, DOI: 10.4135/9780857020062.n8.

Hurel, Arnaud and Noël Coye (eds.) [2011], *Dans l'épaisseur du temps. Archéologues et géologues inventent la préhistoire*, Paris: Publications scientifiques du Muséum national d'histoire naturelle, 442 pp.

Kaeser, Marc-Antoine [2011], "Préhistoire et sciences naturelles : complexe d'Œdipe, tabou de l'inceste ? À propos du 'Grand Partage' nature/culture dans l'histoire et l'épistémologie de l'archéologie préhistorique," in *Paysage... Landschaft... Paesaggio... L'impact des activités humaines sur l'environnement du Paléolithique à* *la période romaine*, ed. by Jacqueline Studer, Mireille David-Elbiali, and Marie Besse, Cahiers d'archéologie romande, 120, Lausanne: Cahiers d'archéologie romande, p. 251-261.

Laming-Emperaire, Annette (ed.) [1952], *La découverte du passé. Progrès récents et techniques nouvelles en préhistoire et en archéologie*, Paris: Picard, 363 pp.

Lyman, R. Lee and Michael J. O'Brien [2006], *Measuring Time with Artifacts. A History of Methods in American Archaeology*, Lincoln and London: University of Nebraska Press, x–346 p.

Plutniak, Sébastien [2017], "The Professionalisation of Science – Claim and Refusal: Discipline Building and Ideals of Scientific Autonomy in the Growth of Prehistoric Archaeology. The Case of Georges Laplace's Group of *Typologie Analytique*, 1950s–1990s," *Organon*, 49: *Approche historique des structures de l'archéologie préhistorique et protohistorique aux XIXe–XXe siècles*, ed. by Arnaud Hurel, p. 105-154, HDL: 10670/1.y5rnm6.