



Archaeological information-making activities according to field reports

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ABSTRACT

Accounts of how scholarly information is produced are crucial for understanding and using the information yet they are often criticized for being incomprehensive or even non-existent. This article aims to increase the understanding of how scholarly information-making is conceived and documented by information-makers. By analyzing how a set of archaeological field reports describe different aspects of the information-making activities (cf. Activity Theory) pertaining to the research documented in the reports, the study suggests that scholars might have a tendency to focus on reporting tools, outcomes and physical location of activities while descriptions of especially rules/norms, community factors and division of labour are rare and expected to be known tacitly. The findings suggest also that the descriptions of information-making activities become comprehensible in relation to their related activities. Therefore, an increased emphasis on explicating their underpinning social factors and how activity systems and their elements link to other activity systems could improve the comprehensiveness of documentation and decrease the need of tacit contextual knowledge.

1. Introduction

A growing body of literature is analyzing researchers' information work and how scientific and scholarly information comes into being (Börjesson & Huvila, 2019b). This work has focused on supporting and understanding scholarly and scientific knowledge-making and the resulting information and knowledge (Palmer & Cragin, 2008). Especially more recently, an additional focus of these efforts has been to develop means to describe scholarly information-making practices in adequate detail to facilitate the reuse of scientific and scholarly information (Huvila, Sköld, & Börjesson, 2021; Pasquetto, Borgman, & Wofford, 2019). In contrast, there is less research on how researchers, similarly to professionals in general, themselves conceptualize and document their information-making, what they consider to be significant to describe when doing so, and how they determine the appropriate means and level of detail to document.

The present article inquires into the documentation of scholarly information-making by explicating how information-making activities are documented in Swedish archaeological field reports. Archaeological fieldwork functions as a fruitful case in this respect due to the variety of ways information, ranging from accounts of observations to sampling for lab-analysis, is generated and how information-making links to knowledge production and societal processes far beyond the scholarly sphere.

2. Problem statement

The aim of this article is to increase the understanding of the significant dimensions of how scholarly and scientific information-making is conceived and documented by information-makers. Doing this addresses the relative lack of earlier research in this area. In particular, this article tackles the problem of the currently incomplete understanding of: 1) how researchers and professionals document their information-making activities, 2) what aspects of information-making are foregrounded, concealed and obscured in the resulting documents, and 3) how the present forms of documentation could be developed to incorporate a more comprehensive description of information-making from the premises of the information-making itself. By zooming into information-making (as in Huvila, 2022b), this study focuses on the second-order documentation of scholarly hands-on making-information-to-happen and its underpinnings rather than on the creation or production of information as a (creative) exercise or a schematic (production) process. As such, this article does not seek to provide an outline of scholarly information practices, information work or data work (for these, see Foster, McLeod, Nolin, & Greifeneder, 2018; Palmer, Weber, Muñoz, & Renear, 2013; Palmer & Cragin, 2008; Palmer & Neumann, 2002). In order to delineate what elements of information-making are documented and left undocumented in analyzed material, the study leans on Activity Theory as developed by, among others, Leont'ev and

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Engeström (Engeström, 1987, 1999). Activity Theory is an established systematic framework for describing and theorizing activities and their constituents, and as such is appropriate for the research at hand.

3. Literature review

3.1. Scholarly information-making

The literature on scholarly information-making spans a large number of disciplines and covers both individual information practices and broader processes of producing research-based knowledge (Bijker & Pinch, 2012). So far, the primary interest of information studies scholarship on scientific and scholarly practices has been on quantitative and qualitative studies of scholarly communication (i.e. dissemination) and information acquisition. However, lately the interest in information creation and making has been increasing. This applies also to empirical work on scientific and scholarly information-making both specifically (e.g. Suorsa, Suorsa, & Svento, 2019) and as a part of research on mapping scholarly activities in general (e.g. Kelpšienė, 2018).

Several scholars, including Pilerot (e.g. Pilerot, 2015; Pilerot & Limberg, 2011) and Palmer (e.g. Palmer, Cragin, & Hogan, 2007; Palmer & Neumann, 2002) with colleagues, have underlined the significance of exchange and active translation between and within communities in the context of interdisciplinary scholarship and the emergence of new research communities. Information sharing entails writing (Palmer & Neumann, 2002), drawing (Moser, 2014) and assembling information in a shape, for instance, in a publication (e.g. as in Pilerot & Limberg, 2011) that makes it information for a particular purpose and audience. Unsurprisingly, the role of communities, tools and material artifacts, as well as the central importance of tacit knowing rather than explicit documentation for information sharing, has been observed just as in earlier information research (e.g. Fry, 2006; Suri & Ekbia, 2015).

In parallel with studies of information creation in science and scholarship at large, there is an emerging corpus of work that has focused on archaeological knowledge production and information-making (e.g. Börjesson & Huvila, 2018, 2019a; Khazraee, 2019). Lönnqvist (2007) observed that archaeologists' research processes can vary to a considerable degree. Buchanan (2016) has studied information creation from the perspective of curation of archaeological collections and underlines the discontinuities in the archaeological information creation process. Huvila (2018) has referred to such discontinuities by highlighting the gap between information-making and information taking and the significance of understanding the measures how archaeologists bridge the gap to maintain a continuum.

As a whole, earlier research has demonstrated that archaeologists use and produce a broad array of different types and forms of information, from the physical archaeological stratum and finds to written documentation, photographs, drawings and diagrams (Huvila, 2014), and rely on multiple modalities of informing and getting informed. Information-making ranges from writing to talking (Morgan & Wright, 2018) and physically engaging (Hodder, 1997; Olsson, 2016) with diverse forms of evidence. However, while being physical, embodied (Olsson, 2016) and personal (Åsa Berggren, 2015; Edgeworth, 2012), archaeological information-making has also been found to be anonymous and institutional (Huvila, 2017) in relation to archaeology as a particular system of knowledge and knowing.

3.2. Archaeological reports and the documentation of professional and scholarly information-making

Traces of information-making—as in other forms of information and data work and practices—can be found across the diverse formal and informal outputs of scholarly processes. Some of these traces are explicitly produced to document scholarly practices and their premises. Such documents include laboratory notebooks (Shankar, 2004) and field diaries (Fowler & Givens, 1995), methods sections of research papers,

and increasingly, various forms of researcher-generated provenance metadata (Missier, 2016) and paradata (Edwards, Goodwin, O'Connor, & Phoenix, 2017; Huvila, 2022a) that are produced to improve the findability and reusability of research data. Recent demands for accountability and transparency, and the parallel surfacing of “openness” as an eclectic societal imperative (Mabi, Plantin, & Monnoyer-Smith, 2017) have contributed further to a proliferation of standards and taxonomies for scholarly methods and practices (e.g. Blanke & Hedges, 2013; Borek, Dombrowski, Perkins, & Schöch, 2016; Reimer, 2009) aimed at an increasingly meticulous explicit documentation of research processes across the disciplines.

In spite of the efforts to standardize reporting practices in archaeology (e.g. RAA, 2015a; Rudebeck, 2015), there is a considerable degree of variation between individual projects and actors with even more variation between archaeological sub-disciplines, countries and regions (Börjesson, 2015b; Baake, 2003; Caldararo, 1984–85). Archaeological reporting is conditioned by a plethora of parallel formal and informal rules, conventions and expectations (Börjesson, 2017) originating from a large number of stakeholder groups (Huvila, 2016b). Theoretical paradigms (Hodder, 1989) and diverging epistemological views (e.g. Sinclair, 1989 cf. Tilley, 1989; Huvila, 2016a) have had an impact on the extent to which the documentation has been and is expected to be considered as objective description or subjective reflection. Different professional bodies and jurisdictions have developed policies (Börjesson, Petersson, & Huvila, 2015) and issued legal and administrative guidelines for archaeological fieldwork and reporting (White & King, 2007 e.g. Government of Ireland, 1999; Museovirasto, 2020; RAA, 2015a). Field and site manuals (Collis, 2013) provide technical guidance on how to implement administrative and scholarly guidelines in practice. In a very tactile manner, the infrastructures (Huvila, 2019), forms (Pavel, 2010), tools and interfaces (Dallas, 2015) used in the scholarly work steer not only the documentation of archaeological features but also the documentation of the documentation activities themselves. As a result, archaeological information-making is far from being unregulated (Börjesson, 2015a; Börjesson et al., 2015). In contrast, it is subject to multiple partly complementary and contradicting forces with their respective expectations, aspirations and requirements (or, regimes of information, as for Ekbia & Evans, 2009) of what counts as “good quality,” what information should be included, what types of tools should be mentioned and how a report should be structured (Börjesson, 2015a; Huvila, 2011). However, while their inbetweenness with respect to multiple communities of stakeholders make reports reasonably useful as information sources within and across different user groups (Huvila, 2016a) it means also that reporting and its quality are constantly contested (Huvila, 2011), and there is a persistent conflict between increasing standardization and the need for flexibility to accommodate local preferences and rules (Huvila, 2012).

There have been recurrent calls to improve the quality of reports and reporting practices, including the documentation of the aspects of work that entail information-making (Faniel, Kansa, Whitcher Kansa, Barrera-Gomez, & Yakel, 2013; Gustafsson & Magnusson Staaf, 2001) in archaeology and other disciplines. It is not uncommon that descriptions of what was done and their aims can be missing or implied as something too obvious to report (Collis, 2013). Documentation is also often dispersed across different types of data (Niu & Hedstrom, 2008), and it tends to remain implicit if procedures are not explicitly enumerated (Valtonen, 2007). Even if a lot of contextual information is implicitly available in the results, descriptions of procedures are indispensable for interpreting the findings in adequate detail (Fowler & Givens, 1995) and in broader terms, to understand the context of investigation and its results (Faniel et al., 2013). More recently, some progress has been made also to exploit the descriptions in information retrieval (Pertsas & Constantopoulos, 2018).

4. Analytical framework

To investigate the significant dimensions of scholarly and scientific information-making activities as they are conceived and documented by information makers, this study turned to Activity Theory (AT). AT offers a concise framework (cf. Wilson, 2013) for explicating information-making and its social, cultural, individual and material elements and outcomes. AT has been successfully applied for describing activities in multiple domains, from education (e.g. Daniels, 2013) to information science (Wilson, 2008). In information behavior research, Allen with colleagues (e.g. Allen, Karanasios, & Slavova, 2011; Dunkerley, Allen, Pearman, Karanasios, & Crump, 2014; Mishra, Allen, & Pearman, 2015) and Wilson (2008, 2013) have engaged with AT for theorizing and explicating different information activities and their constituents, ranging from information seeking to creation in a broad range of contexts (Wilson, 2013, also e.g. Allen et al., 2011; Hovius, 2018; Bata, Norman, & Allen, 2020; Riley, Allen, & Wilson, 2022). In the broader information field, the theory has gained traction, especially in information systems and technology (e.g. Karanasios et al., 2013; Karanasios, Nardi, Spinuzzi, & Malaurent, 2021), human-computer interaction (Kaptelinin & Nardi, 2012a) and communication research (Spinuzzi & Guile, 2019). The theory has also been used as a basis for developing ontological models for describing scholarly practices, although as it appears, primarily as an inspiration (Benardou, Constantopoulos, Dallas, & Gavrilis, 2010) for conceptualizing subjects, objects, actions and their goals rather than as a comprehensive theory of scholarly pursuits in general or information-making in particular.

Fundamentally, AT is a theory for explaining human consciousness and action originating in the Soviet psychology of Vygotsky, Luria and Leont'ev. Since the 1980s it has been developed especially by Engeström and colleagues in education and developmental research (Kaptelinin, 2012). The theory is well known for its diagrammatic conceptualization of activities and their elements—in Vygotsky's version as a single triangle (formed by subject, object, and tools and instruments), and later in the rendering of Engeström (1987) (following Leont'ev) as a two-level system of triangles with the additional elements of rules and norms, community, division of labor and outcome (Fig. 1). In third-generation AT (Engeström, 1999), individual activity systems are linked together by connecting them through their respective outputs to chains of activities (Engeström, 2009) that carry a certain resemblance to the archaeological notion of operational chains or *chaînes opératoires* (Delage, 2017; Leroi-Gourhan, 1964). An emerging fourth-generation AT has been proposed to address the challenge of social and peer production for AT that in earlier renderings has perceived activities as fairly well-bounded units (Spinuzzi & Guile, 2019). A parallel dimension of AT

to the iconic triangle is the distinction of operations, actions and activities. A motive-oriented *activity* is realized through goal-oriented actions. An *action* can enact different activities and are realized through *operations* that are routine processes and oriented towards the specific conditions under which a subject is taking action (Kaptelinin & Nardi, 2012a).

In contrast to much earlier information research based on AT, the present study inquires into information (or, documentation) on a particular type of information activity—that is, information-making—rather than to information objects and systems and their role in activities or information activities themselves. To this end, the focus lies in explicating how different elements of information-making activities (or more precisely, activity systems) are documented in archaeological field reports that are expected to document both information made during an investigation (i.e. its results) and the information-making process itself.

The name *Activity Theory*, as it has been translated into English, is somewhat misleading. The original Russian term used for activity, *деятельности*, refers to transformative action rather than activities in general. Similarly, the original connotation of the word translated as the “object” in activity in the theory, *объектом*, connotes the relevance of an entity to particular interests or purposes (Kaptelinin, 2012). However, researchers have tended to interpret objects in AT more commonly as raw materials (Kaptelinin, 2005) rather than concerns (Engeström, 2014; cf. Engeström, 2009). Another key aspect of AT is its focus on the cultural and historical context and situation of activities (hence its full name, though only sometimes used, Cultural-Historical Activity Theory); but as Wilson (2013) criticizes, the cultural-historical anchoring of activities is not always brought to fore in research using AT.

5. Archaeological reports and contract archaeological process in Sweden

The reports analyzed in this article come from Sweden, where the majority of all archaeological fieldwork is conducted prior to land development rather than initiated by a scholarly research interest. Since the 1990s, fieldwork is organized as a semi-regulated market (Börjesson, 2016). The work is contracted to private and public operators, currently 50–70 in total, by County Administrative Boards (CAB) (Löwenborg, Jonsson, Larsson, & Nordinge, 2021). The CAB determines the aims of each archaeological survey in an inquiry guideline (in Swedish, *förfrågningsunderlag*) that also frames the overall level of detail of the investigation. When the investigation is smaller, the CAB can refer to a generic inquiry guideline. In larger projects, the guidelines are more detailed. In a full-scale archaeological investigation, the contractors are expected to set and follow specific scientifically and scholarly motivated research questions in their work (RAÄ, 2018, also Söderström, 2018; Börjesson & Huvila, 2019a; Larsson & Löwenborg, 2020; Huvila, 2021). The presumption is that the investigation should be able to address these questions and provide at least partial answers.

An investigation is written down in a report, which is filed with the CAB. The reports are expected to follow national guidelines (RAÄ, 2015a) that are, however, fairly generic and do not include a specific template or prescribe the use of particular standards, vocabularies, or metadata schemes. Rather than being uniform and strictly structured, the length and structure of the reports vary considerably even if they tend to cover the topics prescribed in the guidelines and consist of a textual description of the investigation and its results typically complemented with a set of photographs describing the site, the work and its results, appropriate plan and section drawings, and lists of uncovered features and finds (Gustafsson & Magnusson Staaf, 2001; Huvila et al., 2021). A report contains little structured metadata. In practice, the only semi-standardized and semi-structured metadata in the document consists of the so-called administrative information (RAÄ, 2015a), which includes the project ID and date, personnel, the extent of the investigated area, its geographical location, the coordinate system used in

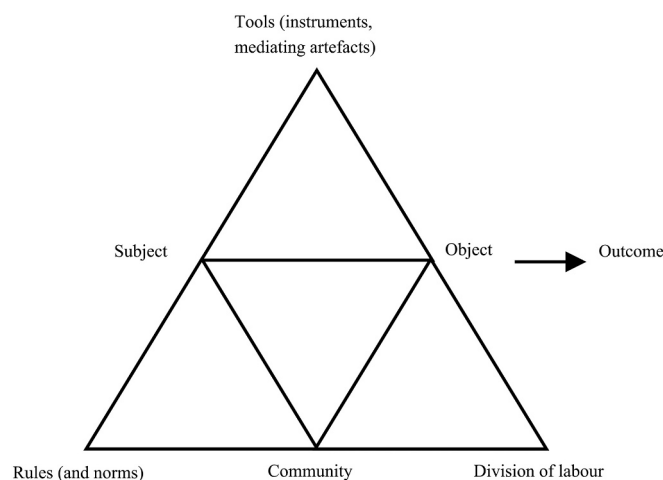


Fig. 1. Activity system model (based on Kaptelinin & Nardi, 2012b Fig. 2.4. and Engeström, 2001 Fig. 3).

spatial information, a list of finds, and information on where the finds and documentation material are archived. The documentation of both archaeological information and the information-making procedures in the reports is expected to satisfy the needs of a broad range of audiences, including land developers and planners, field archaeologists and researchers, and ideally also to a certain extent the general public.

Besides filing reports, there are also routines for archiving additional administrative information about the work at the historic environment register and depositing the primary fieldwork data that underpins the report. This material includes all plans and measurements, photographs, field observations, and eventual samples and finds. In practice, there is considerable variation in implementing and following the routines and a lack of infrastructure for properly archiving material, especially digital material (Gunnarsson, 2022; Huvila, 2016b).

6. Methods and material

A random sample of every tenth archaeological report from 2018 (55 out of 555 reports) available in 2021 in the digital repository of the Swedish National Heritage Board (SAMLA) was downloaded for analysis using a script developed for this purpose. The sample consists of born-digital reports on projects across Sweden produced by multiple archaeological contractors. The corpus (Huvila, 2021a) was cleaned of eight works that were not investigation reports, leaving 47 reports to be analyzed. The sample was analyzed by the first author. NVIVO 12 was used in the preliminary coding of the material. A code system was developed on the basis of the elements of the AT, including: 1) activities (i.e. activity systems), actions and operations, 2) subjects, 3) objects, 4) instruments and mediating artefacts, 4) rules and norms, 6) communities, 7) division of labor, and 8) outcomes to explicate how different types of information-making activities were documented in the material. The categorization was adjusted and augmented inductively during the analysis with sub-categories for specific types of activities and elements identified in the data. The reliability of the categorization was assessed a month later using negative case analysis (Lincoln & Guba, 1985).

7. Findings

7.1. Information-making activities

Across the material, it was possible to distinguish information-making activities based on the type of investigation reported and the activities relating to specific tasks pertaining to archaeological inquiry and information-making. The breakdown of the activities (Table 1) largely follow the categories of archaeological investigations in the Swedish contract archaeological system (RAÄ, 2015b), defined in the historical environment legislation and guidelines. Because of their normative nature, the type of activity was generally indicated in the report explicitly and the documentation of same types of activities generally echoed each other. In the most cases, one report documented one activity, although in some cases a single description spanned multiple consequent activities (e.g. pre-investigation and archaeological investigation, see Table 1). In some cases, additional descriptors could be added to characterize the nature of the reported information-making activity, for instance, by writing “in-depth pre-investigation” (S2, S10) instead of mere pre-investigation.

In addition to describing activities, the analyzed reports featured descriptions of information-making actions that were contributing to reaching the underlying motives of the activities, and further, references to operations (Table 2 cf. Kaptelinin & Nardi, 2012b) through which the actions were realized.

Similarly to how AT conceptualizes actions and operations (Kaptelinin & Nardi, 2012b; Kuutti, 1996), the identified actions are clearly goal-oriented to generate particular types of information (e.g. observation data, analysis results, interpretations), and the operations—even if not necessarily automated—routinized and tacit to an extent that their

Table 1
Information-making activities based on the type of reported investigation.

Activity	Description	Examples
Pre-study: Stage 1 (utredning, steg 1)	Information-making based on studying maps and archival materials and a non-intrusive field survey to find sites and potential areas of sites.	S12, S15, S21, S23, S26, S38, S53
Pre-study: Stage 2 (utredning, steg 2)	Information-making based on site investigation using test pits and trenches in the areas of interest indicated by the stage 1 study.	S12, S15, S23, S29, S38, S39, S53
Pre-investigation (förundersökning)	Information-making based on partial investigation of an archaeological site for planning an investigation, or to determine the location of the site so that it can be avoided in land development.	S4, S10, S12, S17, S20, S30, S40, S45, S51, S52, S53, S55
Archaeological investigation (arkeologisk undersökning)	Information-making based on full-scale investigation and documentation of a site and retrieval of finds prior to its removal.	S3, S5, S11, S18, S19, S25, S32, S35, S41, S47, S49, S50, S52, S53
Inspection (besiktning)	Information-making based on inspecting a site for information for decision-making.	S27

specifics (e.g. trenching, something “shows” something, measuring, chemical analysis) are seldom articulated in significant detail. Sometimes, only a reference to a specific type of information source (e.g. historical maps in S18) or the presence of documentation material (e.g. photographs, section drawings or a finds list, cf. S33) suggest that a particular type of information-making operation had taken place. It is also common to use synonyms to refer to similar or comparable actions and operations. For example, a typical Swedish term used for the removal of topsoil in the reports is “avbaning” (e.g. S12) but also other terms, including, “avtorvning” (de-turfing i.e. removal of topsoil turf e.g. in S2, S44) and “vegetationsavbaning” (removal of vegetation in S40) are used. Excavating or digging are also described using such quasi-synonyms as “taking up” (e.g. S19, S20, S42) and “removing” (e.g. S2). The heavy use of quasi-synonyms, overlap and complementarity between different parts of the reports mean that much of their content becomes decipherable only in relation to other information in the report itself but also in the larger constellation of reports describing past and parallel information-making activities and their elements.

The reports refer to information-making activities, operations and actions that were performed (e.g. what was excavated or documented) but also occasionally to things that were not done. For instance, S40 describes how pollen samples were taken in one of the excavated areas but not elsewhere because it was not considered necessary. Comparably, a report might explain why some planned investigation methods were not used (e.g. trial trenching in S48). There is also certain variation in whether the reasons (objects and goals) for performing certain activities, actions or their underlying operations are indicated or not – suggesting that sometimes explanations are considered necessary and sometimes they can be omitted as too obvious (e.g. S40). In rare occasions, reports refer to failures, for instance, when a layer was accidentally removed (e.g. S10) or a working hypothesis proved to be wrong (e.g. S25).

7.2. Elements of information-making activities

After identifying information-making activities, actions and operations, the analysis commenced by examining the extent to which the reports described the different elements of activities as explicated in the activity systems model (Fig. 1).

Table 2
Actions and operations pertaining to an archaeological investigation.

Actions	Description	Examples of operations relating to actions
Excavation	Excavation (i.e. digging) using different types of tools.	machine trenching (Swed. schaktning) using an excavator (e.g. S10, S11, S33, S44); exploratory machine trenching (Swed. provschaktning); (archaeological) excavating (Swed. utgrävning) (e.g. S10, S28); excavating (e.g. S29); excavating by hand (Swed. handgrävning) (e.g. S10, S11, S18, S33, S44); removal of top soil (Swed. avbaning) (e.g. S12, S25, S32, S40); cleaning by hand (Swed. handrensning) (e.g. S17); roughcleaning (Swed. grovrensa) (e.g. S2); finecleaning (e.g. S32); (test) drilling (e.g. S30, S44); cleaning (with an excavator or by hand e.g. S31); sectioning with an excavator (e.g. maskinsnittning, e.g. S44); cleaning visible (Swed. framrensning) (e.g. S5); exploratory machine trenching (Swed. sökschaktning/schaktdragning/sökschaktgrävning) (e.g. S7, S8)
Observation	Observing aspects of archaeological interest using various means of observation.	inspection (e.g. S38, S44) or ocular inspection (e.g. S21); survey or field survey (e.g. S15, S26); archaeological supervision of machine excavation (Swed. schaktningsövervakning, e.g. S32, S46, S50); archaeological monitoring (Swed. arkeologisk kontroll, e.g. S35, S41); emergence (Swed. framkomma) (e.g. S7, S10, S15, S52); encountering (Swed. påträffa) (e.g. S10, S40); seeing (e.g. S18); reviewing (e.g. S3); coming into sight (Swed. framträda) (e.g. S33); finding (e.g. S33, S36, S48), discovering (e.g. S40); noticing (Swed. notera) (e.g. S45)
Data capture	Capturing data (including physical objects and measurements) during an investigation.	(capturing) samples for scientific analysis (e.g. S10, S11, S19, S25, S36); measurements (e.g. S10, S12, S17, S18, S19, S20, S23, S25, S29); finds (e.g. S10, S18, S27, S33); and photographs (e.g. S2, S3, S25, S33, S45); metal detecting (e.g. S20, S27, S32, S39, S44); picking up material (e.g. S10); mapping (S44)
Documentation	Registering observations and data e.g. in a notebook or information system.	Conducted using specific mediating artefacts (tools) and/or to produce outcomes incl. Information systems (e.g. S4, S8, S20, S23, S33, S45); context form (e.g. S25); graph paper (e.g. S25); context list (e.g. S25); sections (e.g. S3, S4, S31, S36, S51); plan (e.g. S4, S36); description (e.g. S7, S33, S45); finds lists (e.g. S5);

Table 2 (continued)

Actions	Description	Examples of operations relating to actions
Analysis (of materials)	Examination of material for eliciting information (e.g. C14 or dendrochronological dating, analysis of old maps and archival material, tree species analysis, osteological analysis).	specific file formats used (e.g. S11) C14 (e.g. S10, S11, S15, S20, S25, S31, S32); dendrochronology (e.g. S5, S19) tree species (e.g. S11, S25, S40); archival materials (e.g. S12, S15, S17, S21, S29, S32) and maps (e.g. S15, S17, S18, S21, S23, S26, S29), osteology (e.g. S10, S32, S44); macrofossil/archaeobotany (e.g. S4, S10, S20, S25, S36, S51); existing finds (e.g. S23); lipid analysis (e.g. S25, S36); wear analysis (e.g. S27); metal analysis (e.g. S27); comparative analysis of finds (e.g. S27, S51); chemical analysis (e.g. S36); pollen analysis (e.g. S40, S44).
Contextualisation (of findings)	Comparison of observations or captured data and other, often earlier, data or information.	A find is considered to be “extraordinary” (S20); comparison of the investigated area and old maps (S33)
Interpretation	Explicating the meaning and implications of observations.	Results suggest of a continuous occupation during a given time (e.g. S18); impact of earlier development has been “marginal” (e.g. S18); position of two stocks on the same level suggests that might have been a part of one feature (S19); a feature “was interpreted as” (e.g. S20); “several indications show” (S25); a hypothesised interpretation was falsified (S25); “One theory was” (S25); “it has likely been a part of” (S27); “on the basis of the drilled samples it appears that” (S30); “low amount of charred plant remains can be a result of preservation conditions” (S36); “were interpreted visually when measured by assigning them codes” (S39); “on the basis of cartographic material” (S44)

7.2.1. Subjects

The reports refer to the subjects of the described information-making activities often in an indirect sense and not as a part of a narrative. The passive voice is common, but it does not obscure the fact that the principal subjects in the reports are the field director and the report writer (e.g. S11, S15, S25). They are often the same and only person working in the project (e.g. S2, S18, S19, S23, S26). At larger investigations, the project group (e.g. S20, S32, S51) can be sometimes positioned as a collective subject of an activity, similar to how many reports assign the contractor (i.e. organization) as an initial subject of the investigation project by stating that the contractor “carried out” (e.g. S1, S21) or “performed” (e.g. S10, S20) the investigation. The subjects who are referred to by name are specialists with expert knowledge of particular analytical procedures. Some reports also list subcontractors (e.g. S4, S20, S51, S53) and landowners (e.g. S27) as subjects. Apart from people and organizations, the reports sometimes construe the investigated site as a parallel subject. When observations were used as a basis for drawing conclusions of their nature, the writing was often in passive voice. Finds, features and insights were frequently described as

“found” (In Swedish, *påträffades*) or “emerged” (*framkom*) almost as if the true actor was the site itself (e.g. S10, S12, S7).

7.2.2. Objects

Despite the variety of information-making activities described in the reports, the descriptions share a focus on generating useful and usable information on the actions and operations investigated physical environment as their common object. More specifically, the object could be to describe approaches to interact with the archaeological stratum, features, layers, finds and their immediate physical context, or the local environment as a whole. The reports document both what was observed in the physical environment and how it was approached and transformed in the activity, for instance, by excavating the site in layers (e.g. S33), via test pits (e.g. S55) or context by context (e.g. S51). The complexity or relative simplicity of the stratum could justify the use or non-use of particular methods and making or not of certain documents like section drawings (e.g. S33). Also, for example, a densely built physical environment could limit the possibility to obtain precise GPS coordinates (S33), and contamination and difficult terrain may make it impossible to carry out the investigation in all parts of a site (e.g. S55).

7.2.3. Instruments and mediating artifacts

The reports refer to many instruments and mediating artefacts. Some were *information sources* such as archival material and maps (e.g. S15, S17, S18, S21, S23, S53), databases, earlier reports (in all analyzed reports), published literature and academic theses (e.g. S8, S20, S27, S32), and personal communications (e.g. S20, S27). Apart from being an object of information-making activity, the *physical environment* also mediated them. Reports often refer to how the local geographical context influences activities, either directly or indirectly. Examples of direct references can refer to, for instance, how the scope of the material included in pre-studies is restricted to the investigated site (e.g. a particular property as in S33), or how material is sought from national and local (implicitly, available) sources (e.g. as in S33 specified local and national repositories of digital maps and materials). Indirect articulations can be read in the general descriptions of the site and its surroundings even if they would not contain explicit references to how the spatial context influenced the fieldwork.

Further, the reports make a lot of references to *tools* used for information-making. These include instruments used in actual digging: shovel (e.g. S5, S7, S31, S51), pointed hoe (Swed. *fyllhammare*, e.g. S2, S33), pick (e.g. S5, S7), trowel (e.g. S2, S5, S10, S33, S51), hydraulic excavator (e.g. S10, S12, S17, S18, S31, S33), or more generally, hand tools (e.g. S12). Similarly, reports contain comparable information about documentation instruments. The types of GPS (e.g. S18, S33, S55, S45), metal detector (e.g. S48, S27) digital field documentation system (e.g. S23, S33, S45) and GIS software (e.g. S29) used are mentioned occasionally.

Finally, some reports describe the general archaeological *fieldwork approach* of the investigation that functioned as a conceptual artifact or tool that was used in the activity. In most cases, though, the documentation material contains only indications of the approach. For instance, lists of, respectively, stratigraphic units or layers might suggest of the use of a single-context or layer-based excavation method. A couple of reports refer specifically to the context (S51, S53) or single-context (S47) method. S47 describes the utilized procedure as “usual documentation: measuring of trenches, description of layers and features using single-context method and photography” (S47) whereas S51 contains a brief description of the principles of how stratigraphic documentation was conducted.

Finally, one more set of central mediating artefacts described in the reports are the different types of *documents* used to document the investigated site. While the report can be seen as an outcome of the activities, the different genres of documents that make the report are better described as mediating artifacts. Virtually all analyzed reports contain photographs, maps and plans and a narrative describing the site,

its context, the investigation process and its results. Most of the reports summarize findings in tables, including units (e.g. S18, S23, S33) and finds (e.g. S10, S18, S33). Some reports contain section drawings of trenches (e.g. S10) or drillings (e.g. S30); and some contain appendices with additional data, such as carbon dating of tree specimens (e.g. S15, S25). Whenever finds were retrieved, the finds collection can be considered as an additional documentary element and a non-textual appendix to the report.

7.2.4. Outcomes

While the various documentary elements and genres used in the reports mediate information-making, each report as a whole is closest to what can be described as the principal outcome of the described information-making—to a certain extent together with other documentation material. The reports describe in varying detail the investigated site, information-making activities and their results. The information and its details depend a lot on the investigation type (activity). Full-scale investigations are much more meticulously reported than pre-investigations or inspections as there tends to be more to describe. Also, when an investigation takes place in an archaeologically rich area, the documentation is more comprehensive than on smaller sites (e.g. S10, S15, S18). Correspondingly, when nothing is found, the level of detail can be very spartan – even if also in such cases, there was considerable case-by-case variation (e.g. S17 cf. S26).

7.2.5. Rules and norms

The reports made explicit and implicit references to formal and informal norms and rules of information-making, to varying degrees. Some of the reports cited *inquiry guidelines* and described the aim of an investigation, for instance, as “to document eventual archaeological sites and features uncovered during earthwork” (S33) or in a pre-investigation, to provide necessary information for forthcoming planning and investigations (S55). The level of detail and formulations varied, apparently depending on the specificity of guidelines and report writers’ preferences of explicitly stating the aim (e.g. S10, S11, S12, S15, S17, S50), referring in more general terms to the reasons why an investigation was conducted (e.g. S42, S49, S50, S54) or formally citing an administrative document (e.g. S39).

Only a few reports included explicit *research questions* (e.g. S33, S36, S47), which are required at full-scale archaeological investigations. The majority described only the planned development work at the site and continued with an account of the archaeological interventions. In contrast, the reports contained a lot of implicit traces of *archaeological norms* of information-making. In rare occasions, the reports contain explicit reflection of preferred approaches (e.g. S33). More often the references were indirect, for instance describing how trenches were placed “strategically” (S19) or explaining that layers were reported in “correct stratigraphic order” (S3).

7.2.6. Community

Explicit references to community were relatively rare in the documentation. The presence of archaeological community and more specifically, the professional contract archaeological community, could be sensed in the writing, use of technical terms, exclusion of explicit articulations of, for instance, why some tools or methods were chosen or what was considered as archaeologically interesting or not. References to other communities were less common but in some cases the reports described efforts to engage with the general public (e.g. S38, S51, S52, S55) or the media (e.g. S32, S51). Some of the reports also included sections and figures that were clearly addressing non-professional audiences, for example, charts explaining the Swedish contract archaeological system (e.g. S20, S44), lists of archaeological terms (e.g. S4, S7, S8, S39, S44, S51) and periods (e.g. S7, S10, S17, S35), and specific sections with approachable non-technical descriptions of a particular information-making activity, its results and future implications (e.g. S51).

7.2.7. Division of labor

The reports remark upon the division of labor when they refer to work conducted by archaeologists and by other actors, for instance, when archaeologists are monitoring (e.g. S20, S33, S51) the work of a heavy machine operator. Relating to archaeological work, it seems customary to describe the division of labor if there is something exceptional to report, for instance, when a particular specialist or laboratory has conducted a specific type of analysis. This could happen, for instance, with carbon dating (e.g. S25, S55), tree species analysis (e.g. S25), or when finds (e.g. pottery, S55; metal objects, S39; or bones, S44, S55) were processed by a designated specialist. Many reports are written by the archaeologist who did the reported work alone (e.g. S3, S17, S18, S20, S29, S35, S36, S46, S47, S49). Some reports allude to a division of labor also when multiple individuals had participated in the activity, for instance, by mentioning who acted as a project director, who participated in fieldwork, who wrote the report, and who reviewed it (e.g. S2, S4, S11, S12, S20, S23, S25, S27, S31, S32, S38, S44, S53) to underline the agency of particular individuals and the presence of specific activities. In contrast, the exact division of labor in the field is seldom described in detail.

8. Discussion

8.1. What are descriptions of information-making activities made of?

Concerning the elements of information-making and how they are conceptualized and documented in the reports, the above analysis raises three major issues. First, perhaps unsurprisingly considering their regulated nature, the type of documented information-making activity heavily shaped the general contours of what was documented and how, even if the individual accounts varied a lot in detail. Correspondingly, the categories of the information-making actions described in the documentation correspond with the phases of scholarly process described in earlier taxonomies of scholarly methods and activities (e.g. Blanke & Hedges, 2013; Borek et al., 2016; Reimer, 2009). On the other hand, operations are—quoting AT (Kaptelinin & Nardi, 2012b; Kuutti, 1996)—literally so routinized and tacit as to lack detailed descriptions or even references in the literature. This observation echoes Valtonen's (2007) finding that procedures do not get affixed in documentation if they are not explicitly enumerated; this suggests further that, to stick, procedures need to be identified and named. Even if producing satisfactory universally applicable definitions of operations is undoubtedly impossible considering their variation, routinized and subconscious nature (cf. Kuutti, 1996), it could be useful to work towards a thesaurus with definitions and relations of typical terms used to describe operations like “machine trenching” and its relation to “exploratory machine trenching” or “cleaning” and “rough-cleaning,” including their constituents and implications for information that is generated.

Second, the analyzed documentation of information-making seems to have a tendency to focus on tools/instruments and the outcomes of information-making. Subjects are seldom discussed, even if the identity of the subject can be implicitly inferred as the author of a report. In comparison to how, for instance, the science studies literature has shifted attention to the social aspects of scholarly work (e.g. Bijker & Pinch, 2012; Latour & Woolgar, 1986; Pickering, 1995), the reports describe activities in highly technical terms (cf. e.g. Schiffer, 2014). Information-making related rules and norms, community, and division of labor are described more seldom and generally without extensive detail, similar to how earlier studies of information activities (e.g. Fry, 2006; Suri & Ekbia, 2015) have shown their absence in scholarly communication in general. Much of this silence can be undoubtedly explained by the implicitness of much of this information. Knowledgeable readers (i.e. contemporary archaeologists, or in AT jargon, community) know the conventional division of labor, regulations and in many cases, even what research questions are pertinent and relevant. This observation echoes Collis' (2013) and Davidović (2009)

observations of the enmeshment of tacit and implicit exchange in archaeological knowledge production. It is also conceivable that a part of the relative invisibility of explicit references to social conventions is compensated by references to tools and outcomes. A member of a particular epistemic community knows what a particular tool or outcome implies in terms of information-making, what questions that are possible and pertinent to ask, and the information that will be available (cf. Fry, 2006; Suri & Ekbia, 2015). The general a priori lack of necessity to articulate the social context of information-making also explains the exceptions to the rule. It seems that the social context is explained in detail when there is something unusual to report, or when an explicit effort is made to reach out to a non-archaeologist readership.

Third, the findings confirm and nuance the idea of reports as the outcomes of archaeological investigations and in broader terms, of archaeological information-making in general. Even if it is hardly incorrect to refer to a report as the outcome of an investigation (cf. Huvila, 2016a), it appears that a report is realized as a proper outcome first when it is embedded in another activity system, for example, as a tool or mediating artifact, and when incorporated in a genre ecology (Spinuzzi, 2002) of a longer sequence of activities (Engeström, 2009), or chain of operations (Delage, 2017; Leroi-Gourhan, 1964). The manner in which a particular activity system is reported makes sense when it is linked to other activities, for instance, that pre-studies feed into eventual pre-investigations and investigations, or that a description of an information-making activity is tailored to distinguish and relate its key features from and to other activities. The embeddedness of reports and individual descriptions of information-making in other activity systems is also a premise of their capability to support the activity of that system in a sense that Shankar (2004) and Ilerbaig (2010) describes in the context of scientific records as infrastructural. Even if a report can be read as a description of a particular instance of information-making and its outcome, the description makes much more sense when it is envisaged in the context of preceding and subsequent information activities of seeking information on a particular archaeological site or managing archaeological information—both where it is an outcome and where it has another role in the activity system.

8.2. Towards documenting inter-linked activity systems

The mapping of the contents of archaeological reports to the elements of activities according to AT shows that, as a whole, they do still often provide a fairly comprehensive exposé of archaeological information-making. In spite of the occasional omissions, tacit assumptions (cf. Huvila et al., 2021; Larsson & Löwenborg, 2020), and the diversity of ways activities, actions and operations, and their elements are documented or left undocumented, the findings do not suggest that the descriptions in these reports would be directly inadequate. Considering the heterogeneity of archaeological information-making (cf. e.g. Lönnqvist, 2007; Olsson, 2016; Huvila, 2018) and the case-by-case variation seen in the results of this study, following Star's (1988) notion of ill-structured solutions, these reports can be for good reason characterized in a non-pejorative sense as ill-structured accounts of ill-structured information-making. The diversity of both activities and how they are described do not make them irrelevant, unusable or useless, but it does make individual descriptions and activities difficult to compare with each other.

Whereas it can be relatively easy to establish who did what, where, with what instruments, and with what information sources, the specificity and contents of the descriptions of the social and epistemic contexts and underpinnings of information-making vary a lot more. It is apparent that much of the contextual information is implicitly known to the readers of the documents, and especially in less complex cases, as for Collis (2013), it is unnecessary to go into extensive detail in documenting the obvious. At the same time, however, the variation suggests of the likelihood of widely different understandings of the key constituents of information-making in general. Again this does not need to be a

problem as long as the different understandings are understood by others. However, considering the unceasing debate on guidelines regarding what to document and how (e.g. Hodder, 1989; Opitz, 2018; RAÄ, 2015a; Rudebeck, 2015), it is apparent that the existing descriptions do not provide comprehensive enough transparency for everyone involved. For instance, the problematic inherent biases in “ordinary” information-making procedures (e.g. how investigated sites are selected, what limitations and assumptions guide and curb information-making) highlighted by Larsson and Löwenborg (2020) remain invisible for future users of the information if it is not explicitly articulated. This would undoubtedly also improve the usability of the information in interdisciplinary and emerging research contexts (cf. e.g. Pilerot, 2015; Palmer et al., 2007).

Considering the results of this analysis, it seems that the descriptions of information-making activities focus on their visible constituents rather than on comprehensive but at the same time accomplishable descriptions of the (information-making) activities *as a whole*. Instead of focusing on *what* should be documented and *how*, it seems that more emphasis could be put on how these *whats* and *hows* may connect to form larger aggregate entities. A more comprehensive account would not only focus on a selection of individual constituents of information-making activities but would acknowledge and convey the socio-material complexity of archaeological knowledge production (observed in earlier research, e.g. Khazraee, 2019; Börjesson & Huvila, 2018, 2019a). Together with an account of the immediate constituents of information-making activities, it should incorporate also a reasonable account of their sociomaterial (cf. Latour, 1983) and cultural (cf. Knorr-Cetina, 2003; Pickering, 1992) interlinkages such as aims and assumptions (cf. Larsson & Löwenborg, 2020)—in AT jargon, *objects* of activities—that underpinned the choice of tools and specific information-making methods, descriptions of concepts, explicit references to methods literature and documentation standards, articulations of informal rules and conventions (cf. Börjesson, 2017) and, for example, what future activities the making of a particular piece of information is expected to support. Working with AT crystallizes this by making it apparent how the richness of individual descriptions of information-making is accountable not only to the elements of activities (e.g. subjects, objects or tools) but also how they come together in activity systems (e.g. what tools were used in machine excavation or who conducted wear analysis) incorporating a plethora of underpinning actions and operations.

From the perspective of activity-oriented theorizing, a comprehensive description of information-making unfolds as bundles of interlinked activity systems (as for Engeström, 1999) rather than that they would constitute a particular form of data. In such bundles, a detailed description of some elements can to a certain extent compensate for less detailed descriptions of other elements. They gain resilience through “asymmetrical redundancy” even if they do at the same time emerge as “condensed” (Lemonnier, 2012) descriptions of activities rather than their duplicates. Condensation allows them to pass on tacit or wordless messages while the redundancy of the elements provides multiple pathways to convey them. By tying the descriptions of individual activity systems to each other (cf. Engeström, 1999), the individual descriptions of information activities can be linked together as sequences of activities, or to borrow a term from archaeology proper (Delage, 2017; Leroi-Gourhan, 1964), *chaînes opératoires*. As Lemonnier (2012) remarks, a comprehensive documentation of a *chaîne opératoire* of interlinked activity systems can communicate aspects of the context and situation of (information-)making beyond the individual activities and their elements. In documenting archaeological information-making this could, for example, be accomplished by linking field reports to the land development administration document chain in which the rules and norms governing the report’s scope and ambition becomes contextualized. Recalling the critique of operational chains (e.g. Djindjian, 2013), neither descriptions of information-making activities nor their sequences should not be essentialized but considered perhaps rather as

“memory aids that help identify and locate the many relations, agents, and factors” (Lemonnier, 2012) involved in the activities than their representations.

9. Conclusions

The analysis shows that archaeologists conceptualize and document their information-making activities by referring to them through describing different combinations of elements of activity systems, actions and operations. The level and structure of documenting specific undertakings are dependent on the documented activity. The findings suggest that in contexts where the documentation of information-making focuses on enumerating actors, tools and outcomes, an increased emphasis on explicating how activity systems and their elements link to other activity systems and their elements (e.g. aims, assumptions, that steered choices of tools and specific investigation methods, descriptions of concepts, explicit references to methods literature and documentation standards and what future activities may be supported by the making of a particular piece of information) could improve the comprehensiveness of the documentation of information-making and decrease the need of tacit contextual knowledge. When considering the transferability of these findings to domains beyond Swedish contract archaeology, some caution is obviously necessary. It is likely that besides the context-specific tools, actors and conventions of information-making, especially the degree to which descriptions of individual constituents of activity systems can compensate each other, are especially distinct to particular domains. For this reason, relevant directions of future research include comparable studies of how information-making is documented in other domains and how the documentation is perceived to function, and also how much and what type of information about an information-making activity system is necessary to make that activity intelligible for someone who has not participated in the activity herself.

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CRedit authorship contribution statement

Isto Huvila: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing. **Lisa Börjesson:** Conceptualization, Writing – review & editing. **Olle Sköld:** Conceptualization, Writing – review & editing.

Declaration of Competing Interest

n/a

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