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# Dual materiality and knowing in petroleum production

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### ABSTRACT

This paper explores the relationship between materiality and knowing through the notion of dual materiality. Dual materiality highlights how digital technology becomes important, as its materiality plays an integral part in creating, not simply representing, the materiality of the physical world. We elaborate upon this insight through a theory on sociomaterial knowing grounded in ethnographic fieldwork within a petroleum company. The main theoretical proposition of this theory is that knowing arises from the emerging patterns of interaction between material phenomena, the material arrangements for knowing about these phenomena, and knowledge practices. We elaborate upon this through three predominant modes of knowing in petroleum production: instrumentation, interpretation, and learning. This paper contributes to the broader discourse on sociomateriality by refining ideas of materiality through the notion of dual materiality. We conclude by encouraging further exploration of different materialities in contemporary work and organizing.

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## 1. Introduction

Petroleum is produced from wells drilled deep into geological formations. On the Norwegian Continental Shelf (NCS), a subsea plateau off the Norwegian coast, reservoirs are located thousands of meters beneath the seabed. Directed along kilometers of pipeline towards the surface, the well flow – a mass of liquids, gases and solid particles streaming out of the wells – is physically inaccessible to human inspection. With no way of physically inspecting the mass flowing towards the surface, engineers draw upon real-time data, which is generated by a network of sensors mounted at fixed positions within the wells and along the pipelines, to monitor and control production.

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These material sensor arrangements and knowing are deeply intertwined in petroleum production. Thus, the premise of this paper is that knowledge cannot be studied and understood separately from the material arrangements of sensors and other computing equipment that generate and visualize data about the mass streaming out of the wells. Due to the inaccessibility of the well flow and the engineers' dependence on sensor data for knowing about the well flow, it is meaningless to attempt and distinguish between what they know about the well flow and the means by which they know it. We therefore approach knowing in petroleum production from a sociomaterial perspective, which emphasizes the intertwined nature of human knowledge, sensors and other computing equipment for generating and visualizing data about the well flow, as well as the knowledge practices involved in understanding and controlling the flow of fluids, gasses, and solids streaming out of subsurface wells.

Knowledge has been a sustained interest within information systems (IS) literature. Broadly speaking, this literature can be organized into two perspectives on knowledge: an objectivistic perspective on the one hand, and a human-centric perspective on the other (Walsham, 2001). From an *objectivistic perspective*, knowledge is seen as representations of the external world with a focus on capturing and classifying real-world objects. This view is prevalent within IS literature in general, underpinning the many forms of modeling that are central to IS development such as requirements modeling, software design, as well as data and information modeling. From an objectivist perspective, the relationship between knowledge and computing technologies is threefold (Alavi & Leidner, 2001). Through data collection, ICTs aim to capture aspects of reality that can be represented in computerized models. When objectified through these models, knowledge can then be stored in repositories and transferred throughout the organization.

To a certain degree, a *human-centric perspective* offers a response to and critique of the objectivist perspective on knowledge. At its core, this critique is leveled against the predominant focus on representational notations, which has been repeatedly argued as excluding the knowing subject – humans (Boland, 1987; Bolland & Tenkasi, 1995; Orlikowski, 2002). From a human-centric perspective, knowledge is “not an external, enduring, or essential substance” (Orlikowski, 2006, p.460) that is inseparable from the knowing subject. Instead, knowing is constituted through everyday work, through human actions and through practice (Brown & Duguid, 1991; Pentland, 1992; Schultze, 2000). Emphasizing practice, a human-centric perspective offers a counterweight to the objectivist tendencies of reducing knowledge to representations of the material reality to be known. Yet, in emphasizing human action and practice, this perspective tends to minimize the role of technology itself (Orlikowski, 2007). As such, this perspective falls under Leonardi and Barley's (2008) broader critique of a strain of research on technology and organizing that tends to focus on “how people organize around the technologies they employ [and] attention gravitates towards the social: interactions, interpretations, behaviors and so on” (p.163).

Both of the above perspectives offer limited analytical traction for studying knowledge in petroleum production, in which real-time data generated by a sensor network plays a central role in the everyday work of monitoring and controlling production. Limiting ICTs to technologies for mirroring and representing the material world, or focusing on how people organize around the ICTs used, reduces these perspectives' ability to analytically reveal the deep intermingling between human knowing and the material arrangements for knowing in petroleum production. This, however, is only part of the more fundamental problem of a tenuous relationship between knowing and materiality (Tsoukas, 1998). By materiality, we mean ‘material reality’; the stuff the world is made up of (Iedema, 2007). We are interested in bringing material reality – both the physical phenomena to be monitored, and the material sensors and other computing equipment used to generate data about the phenomena – into our analysis. Hence, we ask: *What is the relationship between materiality and knowing in petroleum production?*

We propose the concept of *dual materiality* as one way of exploring this relationship. The material arrangements of sensors and other computing equipment that generate and visualize real-time data described in this paper reside along the boundary between the undifferentiated well flow and a world of semantics that says something about this well flow. Dual materiality distinguishes between these two modes of materiality: the material phenomena that the engineers are trying to grasp versus the materiality of the tools from which they approach it. Offered as the main contribution of this paper, the concept of dual materiality contributes towards the broader discourse on sociomateriality within IS and IS-related research by showing how digital technology becomes important because its materiality plays an integral part in creating, not simply representing, the materiality of physical phenomena. Much of the existing research on sociomateriality focuses predominantly upon the materiality of various computing technologies.

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