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Digital Transformations in Healthcare Professionals' Work: Dynamics of Autonomy, Control and Accountability**

Abstract

Digital technologies and the standards underlying them are omnipresent in healthcare. Despite a wealth of knowledge about the relation between standards and issues of autonomy, control and accountability in professional work, we know much less about how digital technologies alter these relations. To address this gap, we present the findings of an in-depth qualitative case study in a medium-sized German hospital and its hospital information system (HIS) with a particular focus on the operating room (OR)-module used in the operating rooms. Conceptually, we draw on the notion of digital objects which allows studying information entities as well as visualizations that represent information entities and their relations in a visual gestalt (e. g. coloured boxes that represent surgeries on a timetable). We found that during 'normal' situations, digital objects influenced professional work towards conforming with professional standards. During 'hot' situations such as emergencies, however, professionals took over and worked around the system. In unexpected situations, control by professional norms effectively overruled control by the standards and guidelines encoded in digital objects. Relatedly, we found that digital objects produce a specific kind of accountability that is mainly rooted in 'visibility management', which determines what becomes represented – i. e. available and accessible – to whom and what not.

Keywords: digital objects, healthcare, professionals, control, accountability
             (JEL-Codes: M10, M14, M15, M41, I10)

Introduction

Digital technologies have a decisive impact on contemporary working life and how it is managed. In this context, the manner how digital technologies change the monitoring and controlling of work is an important theoretical and practical concern (Rosengren & Ottosson, 2017). Such changes have also affected professionals who traditionally enjoyed high levels of autonomy to control their work. Healthcare

professionals are an exemplary case in point. They decide about the use of instruments and treatments in the provision of care to patients, set standards of performance and regulate the nature and volume of medical tasks (Currie & Guah, 2007; Petrakaki, Klecun & Conford, 2016; Timmermans & Berg, 2003). Nevertheless, their autonomy in everyday work is in many ways constrained by professional norms and ethics such as confidentiality, trustworthiness and care for patients (Freeman, McWilliam, MacKinnon, DeLuca & Rappolt, 2009; Numerato, Salvatore & Fattore, 2012; Petrakaki et al., 2016). To some extent, the professional norms and ethics are embodied in standards such as guidelines, classification schemes or checklists, which are then increasingly 'digitalized', i. e. encoded in hospital information systems (HIS) (Timmermans & Berg, 2003; Collen & Ball, 2015).

The tension between autonomy – in the sense of self-regulation at work – or being controlled – in the sense of being steered towards a specific behaviour which is monitored – and the role of standards in upholding or undermining autonomy of healthcare professionals with all its pros and cons are well-known issues in healthcare research and practice (Wiener, 2000; Timmermans & Berg, 2003; Weisz et al., 2007; Numerato et al., 2012). Less is known about how digital technologies alter the relations between autonomy and control as well as accountability. While the fact that standards are increasingly manifested in information systems (IS) has been acknowledged by recent research, there are contradictory findings about the outcomes of computerization and digitalization.

Some commentators have suggested that such standardization interventions prescribe and rationalise healthcare professional work (Timmermans & Berg, 2003) and thus also redistribute power amongst different healthcare professionals (Petrakaki et al., 2016). The valuable findings of these studies also show, however, that there is no easy answer to the question who gains and who loses control: sometimes it seems to be managers (of hospitals or the health care system in general), sometimes it seems to be nurses. Others suggest that technological programmes to change healthcare professional work meet professionals' resistance, reaffirming their powerful position in the healthcare hierarchy (Adler, Kwon & Heckscher, 2008; Freidson, 1974; Waring & Currie, 2009). Against the backdrop of these ambiguous findings, we agree with Petrakaki and colleagues (2016) who conclude that scholars should not only focus on how technology shapes professional work and in what ways, but also under what conditions it does so.

Our focus is on a digital technology in a hospital's operating department. Work in hospitals, in particular in the operating room (OR), is characterized by shifts between working according to plans (e. g. schedule of surgeries, operation standards and guidelines) and coping with unexpected, adverse events (e.g., arrivals of emergency patients, crashes of the HIS). In addition, we take the notion that control and accountability are related to making processes and results 'visible' not only metaphorically. Rather, we study the role of the visual design itself and the organiza-

tional context in which actors draw on it. In the age of digitalization issues of visualization become even more crucial than before (Flyverbom, Leonardi, Stohl & Stohl, 2016). Our focus on visual design extends previous accounts of the role of IS by introducing the concepts of digital objects and visibility management and discussing their role in managing medical professionals' work. Accordingly, we ask *how autonomy, control and accountability change in these situations and what role the digital objects of the HIS play*.

We engage with the research question by presenting the findings of an in-depth qualitative case study in a medium-sized German hospital. To study the effects of digitalization on professional work, we look at the example of a HIS with a particular focus on the OR-module. We conceptualize the role of the HIS via the notion of digital objects which allows us to study information entities (e. g. information about the duration and procedure of a surgery or other clinical practice guidelines) as well as visualizations that represent information entities and their relations in a visual gestalt (e. g. coloured boxes that represent surgeries on a timetable). Amongst the professionals that we focus on are those that perform within operations theatres (i. e. surgeons and medical staff) as well as those that manage these performances with interest in efficient coordination (i. e. OR manager and IT administration).

Our findings are grouped into two main categories. First, we found that the tension between control and autonomy was related to the extent that object-based standardization through the HIS fit the demands of the work situation. Normally, the HIS enforced what a respondent called 'digital coercion' to ensure quality and enabled faster coordination. However, there was also a need for improvisation, in particular when the HIS created unexpected events such as unrealistic representations of surgeries or delays due to system crashes or its slow speed. Whenever these shortcomings became excessive, professionals took over and worked around the system. In these and other unexpected situations, control by professional norms effectively overruled control by the standards and guidelines encoded in the digital objects of the HIS. Second, the HIS produced a specific kind of accountability that was mainly rooted in 'visibility management', which determined what became represented – i. e. available and accessible – to whom and what not. It thereby created transparency about who had performed which work steps and the resources used as well as who was going to do which work and what resources were planned to be used. This transparency was used for holding others responsible for processes and/or results or refuting responsibility and was therefore about creating opportunities for control and the exercise of power.

Our study adds to the literature on the digitalization of professional work by showing how the impact of a HIS on professionals with regard to autonomy, control and accountability varies with work conditions, i. e. when unexpected events interrupt the work as planned. Our conceptualization of the role of the HIS via digital objects allows us to unpack these relations. Our findings show that, in unexpected sit-

uations, control by professional norms effectively overruled control by the standards and guidelines encoded in the digital objects of the HIS. Since a specific focus is on analysing how digital objects enable visibility management practices and how these are related to control and accountability, we also contribute to prior studies of visibility management.

The remainder is structured as follows. First, we review the literature on Information Systems with a specific focus on the nature and role of digital objects. This theoretical background will help to clarify the notion of 'tools', in particular, the HIS that we are focusing on. Afterwards, we present the literature on professional control, standardization and accountability in healthcare work. Second, we will describe our empirical setting, data gathering and analysis. Third, we outline our findings. Fourth, we discuss our findings and how they contribute to the existing literature.

Theoretical Background

Standards, Professional Control and Accountability

Standards such as clinical practice guidelines, classification schemes, design or performance specifications are general models for both the means and the outcomes of a process (Timmermans & Berg, 2003). The relation between standards, control and accountability has been of special interest in inquiries into professional medical work (e. g. Carroll & Rudolph 2006; Chassin & Loeb, 2013; Timmermans & Berg, 2003; Weisz, Cambrosio, Keating, Knaapen, Schlich & Tournay, 2007). A central finding is that the implementation of standards reduces threats to reliability – if all employees, regardless of seniority or professional credentials, are held accountable for adhering to them (Chassin & Loeb, 2013). In addition to the role of standards as means to achieve high reliability, they have been discussed as objects through which control is exercised, and accountability is assigned (Timmermans & Berg, 2003; Waring & Currie 2009). In their influential study, Timmermans and Berg (2003) deliver an in-depth analysis of the role and effects of standards in health care. They find that clinical practice guidelines standardize medical treatments and prescribe a 'gold standard' against which expert work can be evaluated and, thereby, be controlled and made accountable to other audiences.

Control is often understood as 'the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives' (Anthony, 1965, p. 17). While generally following this definition, we add that professionals themselves and not only managers are involved in controlling expert work (Timmermans & Berg, 2003; Waring & Currie, 2009). Controlling professional work is traditionally seen as being substantially different from control over work by non-professionals, owing to the professionals' expertise and medical knowledge which often remains obscure to managers (Wiener, 2000). One of the central problems arising from such an asymmetry is the conflict between

managers and medical professionals. For example, Waring and Currie (2009) show how attempts of hospital risk managers to codify and control medical knowledge represent a significant challenge to the autonomy of the hospital's medical professionals. Another issue that relates to the introduction and reliance of standards is the potential lack of experts' accountability.

Accountability means that someone can be held responsible by others for accomplishing a work task, which includes process and/or the results of this task. Since managers can hardly assess the processes of medical practice and only to some extent its result, issues of accountability and controlling professionals emerge. To deal with the limits of control and accountability of professionals in general, control theory has suggested clan control (Ouchi, 1979), normative control (Hechter, 2008) or identity regulation (Alvesson & Willmott, 2002) as preferred forms of control. Standards and guidelines have also emerged as a powerful form of professional (self-)regulation, which are used to fortify professional jurisdictions, while simultaneously making it amenable to accountability through external quality control.

As Timmermans and Berg (2003) note, all forms of accountability have in common that (health care) professionals are held accountable to third parties for the value of their work. A likely result is that standardization transforms the professional notion of autonomy into one of accountability (Timmermans & Berg, 2003). With the introduction of clinical practice guidelines, the meaning of professional and clinical autonomy has shifted over time and depends on who decides about the standards (Weisz et al., 2007). What is at stake is who decides how medical work should be conducted. When professional organizations formulate clinical practice guidelines, their authority frames the prescriptive character of the instruments. Instead of highlighting the prescriptive nature of guidelines, professional bodies emphasize the educational and decision support function of clinical practice guidelines. The introduction of clinical practice guidelines is then portrayed as a scientific, evidence-based rationality for professional autonomy (Carroll & Rudolph 2006; Timmermans & Berg, 2003).

When third parties seize clinical practice guidelines to regulate medicine, medical professionals' autonomy gives way to accountability. With the rise of IS, a new 'player' appeared on the field. On the one hand, technology embodies constraints in rules which restrict health care professionals' decision making about diagnoses and treatments. Still, healthcare professionals continue to exercise discretion as to how to apply these normative and regulatory standards when they deal with individual cases (Wiener, 2000; Petrakaki et al., 2016). On the other hand, technology enables decision making by providing access to knowledge, either stored in databases or 'in the heads' of other professionals and allowing several groups to make use of the created transparency about past and ongoing operations. Previous studies about the implementation of IS in the healthcare system and in hospitals have largely circled around these two perspectives and explored different technology acceptance models

(e. g. Bhattacherjee & Hikmet, 2007; Melas, Zampetakis, Dimopoulou & Moustakis, 2011).

As the literature review shows, there are several relations between standards, control autonomy and accountability. Basically, the codification of standards by IS is likely to have increased the already existing pressure to submit one's professional expertise and autonomy to standards in order to fulfil stakeholders' quality expectations. Clinical practice guidelines, however, always need to strike a balance between precise prescription and allowance for leeway, accommodating the specific medical history and condition of each patient, which requires expertise and know-how that can hardly be codified. Accordingly, some medical professionals may be in the position to select which guidelines to heed in order to control their image as rational professionals and experts. There is a long research tradition addressing these relations, but we know less about how digitalization via IS impacts them. In particular, existing studies discuss visibility mostly in terms of making processes and results transparent, but only a few discuss the downside of visibility and even fewer explore the role of visual design itself.

Information Systems and Digital Objects

Allen, Brown, Karanasios and Norman (2013) explicitly explore the impact of increased transparency by IS. They discuss two cases in which tensions and contradictions were related to increased control and surveillance of professionals by the introduction of IS. Indeed, in an analysis of a similar system to the one described in this paper, ambulance crews sabotaged the system actively (Wastell & Newman, 1996). Deploying the IS created an informational or electronic panopticon (Zuboff 1988) as work which had been invisible to management became visible. Managerial control increased, and the cultural-historical context prohibited resistance. While scholars emphasized that information was made visible, they were less interested in the visual design, i. e. how information was visualized.

Technologies are constructed out of material and digital artefacts with properties that transcend their context of use. Social constructivist approaches to technology have argued that individuals can exercise their human agency to make choices about how to use the features of new technologies in their work (Barley, 1986; DeSanctis & Poole, 1994). Yet, they tend to overstate the impact of humans ('the social') by neglecting that those features are constructed out of materials that afford certain actions while limiting others. The notion of affordance (Gibson, 1977) highlights that technology invites human agents to perform certain actions, which puts the (non-)material objects that technology consists of into the focus of analysis. During the last years, the IS literature has seen increasing interest in materiality and the materiality of technology in particular (Leonardi, Nardi & Kallinikos, 2012; Orlikowski, 2007, 2010). Putting the emphasis on materiality, however, leads to downplaying or even neglecting the role of nonmaterial objects that are a crucial part of IS.

Some scholars have referred to these as digital objects or digital artefacts (Ekbia, 2009; Kallinikos, Aaltonen & Marton, 2010, 2013; Faulkner & Runde, 2013).

The importance of the distinction between material and digital objects is particularly evident in the realm of computer-based digitalization, where different types of material, technological objects such as desktop computers, servers, workstations, routers, switches, etc. operate together with intangible objects such as software programs, databases, e-mails, digitized images, and so on (Faulkner & Runde, 2013). In contrast to material objects, digital objects lack properties of a physical mode of being such as mass, volume, or location, but can be characterized by a bitstring: a sequence of 1s and 0s (Faulkner & Runde, 2013). In order to further characterize the nature and role of digital objects, we argue that digital objects can be described in terms of information entities and visualizations. Information entities encode data (e. g. text, pictures, audio recordings), and sets of logical instructions about how the data can be processed (Faulkner & Runde, 2013). For example, information entities may encode data about the duration and procedure of an operation or other clinical practice guidelines. In addition to Faulkner and Runde's (2013) account, we argue that digital objects have another dimension which we call visualizations. Visualizations represent information entities but also go beyond them because they also represent their relations in a visual gestalt on some screen (e. g. coloured boxes with text represent a surgery, whereby the colour indicates whether it has started or not or whether it is already finished). It is crucial to note in this respect that the power of the visualization to shape cognition and action cannot be reduced to the parts it consists of (i. e. information entities). Among the important contributions of gestalt-based studies in visual perception is the finding that the contents of our awareness are by and large not additive but possess a characteristic coherence, the gestalt, which is often grasped before the individual parts enter the observer's consciousness (Wagemans, 2012). The crucial consequence for work practices is that the visualizations of digital objects allow employees to grasp complex information faster and easier.

Visibility Management

There is, however, also a 'dark side' of making information visible, which is sometimes overlooked. Making something visible or transparent is not simply a disclosure of information for purposes of clarity or speeding up work processes, but also a matter of creating opportunities for control and the exercise of power (Foucault, 1980). In order to capture this aspect, Flyverbom et al. (2016) introduce the concept of 'visibility management', which is about the many ways of acting on the world by enabling and controlling possibilities for seeing, knowing, and governing. For example, social networking technologies make information and communication visible that were not visible to third parties when the communication occurred through e-mail or the telephone (Flyverbom et al., 2016). A key aspect of visibility management created through digital objects concerns its relation to accountability.

Hutchins (1991) describes the importance of visibility for accountability in navigation teams, where members utilize a 'horizon of observation', i. e. a clear view of what others are doing, as they jointly pilot the ship. Workers, therefore, do not have to formally supervise one another, but by seeing others' task performances responsibilities become visible and parties become accountable for their own contribution while also making other parties accountable for theirs. We build on this literature and understand visibility management as the sum of practices which make work processes and/or results transparent to others through digital objects. Visibility management practices like making information available, granting or removing access to it, and deciding what becomes subject to monitoring, reporting or surveillance may also have been seen as attempts of exercising control and power.

The visibility management-perspective also sheds new light on the types of interaction that digital objects afford. Kallinikos and colleagues (2010, 2013) argue that digital objects are editable, interactive, reprogrammable, and distributable. While we agree that these features can be beneficial for collaboration at work by making it more flexible and faster, we also argue that they enable visibility management practices. Acknowledging that digital objects are editable and distributable gives rise to the question which information entities and visualizations can be edited by whom and how this is monitored or reported. It is very unlikely that everything can be changed and that every user is granted access to the same digital objects. Thus, different users can access and modify different information entities and/or visualizations while others are out of his/her influence. Given that digital objects are interactive and reprogrammable, a similar question arises: Who can enact functions like prescribing or monitoring work procedures, and who is able to reprogram digital objects and/or their underlying principles? We will address these questions in order to explore the relation between digital objects and autonomy, control and accountability in our case study.

Research Setting and Methods

The medical context provides a fascinating setting in which the elements of the above literature review intersect: The HIS as the ubiquitous digital object seems to be involved in the production of visibility through monitoring and controlling medical professionals' work based on standards. This is likely to increase work reliability in a context where unexpected events often occur, but also challenges professionals' autonomy and initiate struggles about accountability.

The setting of our qualitative case study is a hospital in Northern Germany. The hospital has a capacity of 300 beds and is treating emergency and elective patients in 15 different specialized departments (e. g. orthopaedic & trauma surgery, neurophysiology, dentofacial surgery, urology). These departments share the hospital's five central operating theatres, although some departments have their own small operating rooms. Availability of the operating theatres is a scarce resource, and it must be

organized which operating room is assigned to which team (consisting of specialized surgeon, anaesthetist, nursing staff) and the necessary medical instruments.

The HIS offers, amongst others, a module that provides information about the planned, ongoing and forthcoming surgeries in the five operation theatres. It displays the ongoing surgeries in the five operation theatres as a set of boxes and shows additional information when users click on the boxes representing the surgeries. Managing time slots via the HIS is a practically complex task, as it concerns that the operation theatres are used efficiently while leaving room to accommodate emergency patients. Additionally, the allocation of operating time to departments is negotiated between the specialized departments and the hospital management two times per year. In these negotiations, the departments compete for time in the operation theatres. To further complicate matters, labour regulations have to be respected, the entire operation team needs to be coordinated, and sterilized operating instruments must be available. These issues are documented in a guidebook on operating theatre rules and procedures which are part of a larger quality assurance program across the hospital. Most of our empirical observations relate to the OR-module of HIS, which serves as a suitable example to study the impact of digital objects on professional work as it is frequently used and referred to in surgeons' daily work.

Data Collection

We mainly draw on three sources of data which we gathered in two phases: interviews, observations, and documents. In the first phase, we conducted a set of 21 interviews with the hospital's top executive, surgeons and heads of departments (15), the manager of the operating theatres (interviewed twice), the head of nursery (one) as well as the management accounting team (three). In view of our research question, we were interested in the ways that monitoring via the HIS affects the social relations between professionals in terms of autonomy, control and accountability. We started with broad questions like 'How do you use the HIS?' or 'How is the HIS involved in making decisions?' and gradually moved to more focused questions like 'How do you interact with the tool when unexpected events occur?' and 'What is the role of the HIS when it comes to conflicts with other surgeons about treatments or even with patients, e. g. in lawsuits?'. See Appendix A for a list of exemplary interview questions.

In a second step, we gathered data about 'real' practices that supplement the data about 'told' practices. We shadowed (Czarniawska, 2014) the manager of the operation theatres for two days. Each author shadowed the manager for an entire working day, including visits to the operation theatres themselves and other important work sites (e. g. the sterilization unit, the anaesthetic recovery room). We observed his interactions with the HIS, how other organizational members used it and we talked to several staff members. We kept handwritten field notes of our observations and interpretations. In addition, we collected and analysed a number of internal

documents (e. g. a handbook and a manual with rules that form the basis of the OR-module, check-lists, Balanced Scorecard-documents; statistics about emergencies) as sources of data. After our field observations (phase two), we conducted additional eleven interviews (phase three), to make further sense of our observations and confirm initial interpretations. In this third phase, we engaged with experienced surgeons of various departments (four), the administrator responsible for the HIS (one) and organizational support staff (one). We also conducted interviews with anaesthetists (two) and nurses (three) to refine previous versions of our analysis and theorizing.

Data Analysis

The primary focus of analysis is a within-case analysis that allows considering the complexities and dynamics of the role of the HIS as a digital object on professional work. The analysis proceeded in different stages and combined the close reading of data with provisional constructions of concepts, categories and relations between them inspired by grounded theory (Corbin & Strauss, 1990). We moved back and forth between a close and systematically engaged with the empirical material and theoretical inputs from prior literature. First, we conducted open (or live) coding of the data into concepts (Locke, Golden-Biddle & Feldman, 2015), i. e. we were searching for phrases and passages that referred to how and why the HIS was used. Following multiple re-readings of the interviews, we gradually combined codes into more abstract categories. This process was facilitated by referring to our theorizing about standards, control (in professional service organizations), autonomy, information entities, etc. which provided theoretical categories (Locke, 2001) to think about digital objects and their role. Throughout this exercise, we were double-checking interpretations with our observations and field notes. At the end of this stage, we resolved discrepancies through discussion and occasional recoding. Finally, we tried to uncover relationships among our observations ('axial coding'; Locke, 2001). During this stage we found that the role of the HIS varied with the work situations: As long as work could be carried out as planned, the tool played a major role and could be said to be at the centre of interactions. However, when unexpected events occurred, the HIS was backgrounded, and social interactions were at the centre. See Appendix B for the data structure and examples of codes.

Findings

We present our findings of the effects of digital objects on professional work in a medium-sized hospital in three thematic categories: the differences between control and autonomy in 'normal' situations, in 'hot' situations, and the impact of visibility management on accountability.

Digital Objects in 'Normal' Work: Standardization and Control

Obviously, the HIS as the central digital object in our study is closely linked to standards and guidelines because it entails information entities such as the prescribed duration and procedure of a surgery and visualizations such as the representation of ongoing surgeries as boxes and the upcoming surgeries in a separate window on the right sight of the main screen.

The encoded and represented information impacts the way healthcare professionals organise and record their everyday-work: The HIS is at the centre of how they retrieve and use information in order to make decisions about diagnosis, treatments, or how to perform a surgery. Consequently, the emphasis shifts from the expert-based way of organizing to one that is based on standards encoded in the digital objects of the HIS. Our observations support the argument that standards and guidelines facilitate professional work because they allow representing complex work independent of individuals (Timmermans & Berg, 2003). Given the traditional resistance of professionals to external control, a suitable starting point for our inquiry is the role which digital objects play in contests between attempts to control and standardize expert work, or at least representing it in relation to standards, and professionals defending their autonomy as a response.

An aspect in which the HIS directly relates to standards is the emergency classification scheme, which is used to grade how fast a patient needs to be taken to one of the surgery theatres. The system is in accordance with nation-wide standards (Bauer, Hinz & Klockgether-Radke, 2010) and ranges from A to E. A category D patient is judged to need surgery within 24 hours. For category C patients, six hours are the required maximum, two hours for a category B patient. When dealing with a category A patient, surgery is deemed necessary immediately, and an on-going surgery would be put on hold for such an emergency. Patients with an E-categorization are elective patients who get their time slots several days or weeks in advance and are deemed non-critical.

The categorization has a strong standardizing effect on expert work in that it helps to coordinate the work of surgeons, anaesthetists, nurses and support staff according to rules based on national standards to the extent that an on-going surgery is halted. The categorization of patients is noted in the OR-module of the HIS and distributed among the manager of the operation theatres, surgeons and medical staff. In addition, the HIS offers functions to monitor and report on conducted surgeries by category. We will return later to how professionals enacted these different functions when we discuss practices of creating accountability.

The OR-module of the HIS also enabled controlling professional work by prescribing 'what things get done and how they are done'. A salient example of the digital nature of such controls relates to the average duration of surgeries which are given as default values when a new surgery is entered into the system. While these default

values are based on local experts' adjustments of default suggestions when the system was first customized, it was later difficult to change these values. Our respondents repeatedly stated that they know that some of their colleagues would work faster or slower than the default time but that they had to use these prescriptions (if it only were because they did not know how to change them).

Moreover, some restrictions of professional work were explicitly desired and built into the visual design of digital objects of the HIS. The IT administrator told us that he seeks to employ 'digital coercion', which forces professionals to avoid routine behaviour. An example for such a procedure was a series of confirmation clicks necessary to add a new surgery to the system. The pop-up windows have 'Yes' and 'No' buttons which, much to the frustration of the manager of the operation theatre switch positions and therefore 'cannot just be clicked through'. Another aspect of the visual design of the HIS also controlled medical work to some extent. In the OR-module, each surgery is colour-coded in either red or green. Red means that a surgery is in progress, green that it has finished. The information is fed directly from the operating room to the support stations via the many screens which display the OR-module. Several professional groups align their work activities to the signal light: the manager of the operation theatres (for monitoring, planning, and rescheduling), surgeons and nurses of the medical team that will perform the following surgery (for preparing instruments and patients), the instrument sterilization unit (for sterilizing the requested instruments at the right time) and the patient transportation service (for arriving with the right patient). In those instances of organizing, the visual design of the OR-module reduces the complexities of a surgery to a red/green-dichotomy, which allows for orchestrated action among different groups of work.

Digital Objects in 'Hot' Situations: Professional Autonomy

Despite a largely standardized set of guidelines for emergency patients, digital coercion and some professionals advocating standardization, we found instances in which professionals engaged with the HIS to maintain their professional autonomy. These cases usually related to 'hot' situations in which unexpected events occurred and routine behaviour had to be suspended for the sake of fast decision-making and action. Our interviewees reported several unexpected events: emergency patients arrive, scheduled patients, become ill so that the surgery cannot be performed, the hospital-intern patient transport service arrives with the wrong patient or too late at the operation theatre, the planning and monitoring tool has crashed, surgeries took longer than expected etc. When such events occur, professional work cannot be conducted as planned – and since the HIS seems to be of little help, it is backgrounded, and face-to-face interactions dominate. Some of our respondents, especially surgeons, vividly critiqued the abstract and standardized nature of digital objects. For instance, a surgeon remarked with reference to German military strategist von Clausewitz:

Interviewer: 'We had a close look at the OR-module of the HIS. We also had a look how it is made, changed, how it […]'

Surgeon: 'A catastrophe. Clausewitz. The OR-module is pure Clausewitz.'

Interviewer: 'Why?'

Surgeon: 'Don't you know? Well, every battle plan is wasted paper once you engage the enemy. The thing is simply… Well, the worst is, it used to be better. It used to be a sheet of paper […] Now it's digital and is being changed all the time. […] There used to be fewer problems.'

The interviewee goes on to lament the many and quick changes that digitalizing the plan for surgeries has enabled. The above passage is the start of a six minutes and four seconds long monologue by the surgeon, best described as a rant. The main argument, which we repeatedly found discussed by other respondents as well, is that standards do not allow to accurately cope with the complexities of professional work, especially when unexpected events occur. In addition, the increase of standardization via IS distanced the management of expert work even more from actual practice.

The discourse about the HIS had shifted over time. At the start of our study, a new HIS had been recently implemented. While the old HIS was developed in-house and had grown to represent local idiosyncrasies, the new HIS was rolled out for a number of hospitals under the same holding. The effect was a much less customized system. In the first interviews, we found statements such as: 'We used to have a Porsche, and now it's an old East-German car.' (interview, head of department). However, this discourse had gradually ceased to feature in our interviews, and later a member of the planning and support staff remarked that 'one has gotten so used to the new system, that one doesn't know what used to be better any more.' (interview, surgeon).

Still, some critique of the technical aspects persevered. The system was found to be much too slow, took several minutes to boot and would sometimes freeze. Such short-comings led professionals to lament the loss of the old tool or the effects of digital objects altogether. We want to highlight that, due to its shortcomings, the HIS was sometimes moved to the background and face-to-face interaction based on professional norms became pivotal, especially during 'hot' situations. In addition to the well-known norms that underlie the medical profession (e. g. ensure medical confidentiality, patient safety but also that financials are met), we found a norm that we call 'make it work'. The norm circumscribes that it is necessary to put personal sensitivities aside and improvise in order to respond appropriately to unexpected events. While this may ultimately serve patient safety ('what'), the modality ('how') is important. Medical care staff, surgeons and the manager of the operation theatres stressed several times that responding to unexpected events do not come without tensions and that there is, at least temporarily, a harsh communication style. Our interviewees reported, and we also witnessed that particularly surgeons and the manager of the operation theatres engaged in several arguments, for example about

which surgery should be prioritized and about the assignment of nurses which all became subject to re-negotiation when emergency patients arrived. In other unexpected events, for example, when the HIS crashed, the manager of the operation theatres 'did all I could do to keep things going' (second interview, manager of the operation theatres). He provided information about ongoing and scheduled operations, either by drawing on printouts and saved screens of the HIS, or by calling the surgeons, or by going into the operation theatres himself.

Visibility Management

A further set of evidence which concerns the relationship between digital objects and professional works may be summarized under the term 'visibility management' (Flyverbom et al., 2016). In the following, we describe how visibility management is produced with digital objects and that it is a two edged-sword in two ways. First, because it improves and speeds up work processes yet also allows exercising power. Second, because the representation of work processes and results are accessible by several professional groups (such as physicians, nurses, medical assistants and managers), which allows a shared understanding of what is going on and enables coordination but also creates a situation where almost everybody can monitor everybody else.

The HIS creates visibility for a range of practices. Let us continue to take the example of the OR-module. The OR-module can be accessed through various computer terminals distributed across the operation theatre wing of the hospital. All surgeries happening in the five operation theatres are represented graphically by rectangles in columns, much like a conventional calendar. The rectangles contain an amount of information. They are colour-coded to show which department is responsible for which operation. The time per operation theatre per week allocated to each department is subject to frequent micro-political debates among surgeons. The visibility the colour-coding creates is, therefore, closely checked by surgeons because extra time used by a rival department may be referred to in future negotiations. Additional, more detailed information about a surgery is revealed through a mouse-over effect for each surgery-rectangle. The name of the patient, type of surgery and important indicators for assessing the length of a surgery are noted. The measure most frequently mentioned in our interviews was the time from the first cut to completing the sealing of the wound (*Schnitt-Naht-Zeit*). This indicator is important for coordination, since the most crucial 'waste' of time for surgeries are the times between surgeries which include moving the patient out, cleaning the room, moving the next patient in and preparing her or him for surgery (positioning a patient correctly on the table may take up to an hour).

Another facet of the use of information made visible through the OR-module shows the intimate relationship between medical care and accountability. One of the biggest threats mentioned by our respondents was performing surgery on the

wrong patient or the wrong surgery altogether. For instance, operating the wrong leg may be a danger for persons with dementia not reliably aware of their own condition. To prevent such mistakes from happening, a checklist is used to make final checks before the actual surgery commences. The OR-module makes the information which is undergoing what surgery available to more people than just those directly involved. Scandals involving wrong surgeries are major reputational risks for hospitals and are questions of accountability. The visibility the HIS also produces concerns such public forms of accountability since it is well documented who did participate in which surgery in which role. Evading accountability becomes difficult since every nurse, anaesthetist or member of the support staff can check the OR-module for who is involved in which surgery.

A crucial aspect of creating visibility through digitalization is that it enables action at a distance (Latour, 2005). Rather than needing personal contact to exchange information, software like the HIS creates visibility which can be shared across time and space. As a result of action at a distance, practices do, when referring to the software, not deal with actual patients but their representations. Such representations are necessarily selective and incomplete, which gives rise to the question who decides what selections are made. In our study, we found several instances in which representations were the focus of attention. One example is the daily morning meetings of which we directly observed two. In a medium-sized room around 15 people, including the head of emergencies, the manager of the operation theatres and several surgeons, sit together and quite quickly discuss the surgeries planned for the day. Most surgeries are not dealt with in any detail, but those for which the HIS shows anomalies meriting special attention (age, diabetes, etc.) are discussed in more detail. Through referring to those criteria made visible in the HIS alone, the representations of patients become performative. That is, at this point the representation of the patient in the HIS is the patient, there is nothing else which is acted upon. An equal type of discussing representations is only done when the manager of the operation theatre hands over to the night shift.

In theory, the HIS would produce perfect accountability for all that is represented through it. However, we observed a curious practice in which digital and professional representations of accountability diverged. The manager of the operation theatre would regularly, at least four times per day, make screenshots of the OR-module. He would then safe these screenshots by inserting the pictures in a text processing software or print them out. The manager of the operation theatre suggested that producing records of past plans allowed him to spot any differences made at a glance and thereby control surgeons who, at least sometimes, tried to change categorizations in their own interest. For example, 'upgrading' a patient from category C to B does not only result in a higher prioritization in the schedule but also affects medical procedures, for example through shortening prescribed fasting times. Both would mean that the surgery starts earlier and therefore the surgeon could finish working earlier that day. Such category changes were not solely motivated by unam-

biguous medical concerns, as we were told by nurses, anaesthetists, one surgeon and the manager of the operation theatres, but also by self-interests and micro-political gaming when a patient's condition offered grounds for diverging professional judgements. Despite being based on national professional guidelines, individual surgeons have some leeway while categorizing patients. The manager of the operation theatre used the screenshots to control or at least produce traces of accountability of such micro-political games and to remove himself from potential legal accountability.

Discussion

Digital technologies are frequently used in healthcare professionals' work. Although the literature on autonomy and control as well as the role of standards, in general, is vast, we know little about the role of digital objects in shaping medical professionals' work with respect to autonomy, control and accountability. In our study of the use of a HIS, we explored this role and directed attention to how it varies with work conditions, e. g. when unexpected events interrupted the work as planned. Our findings show that, in unexpected situations, control by professional norms effectively overruled control by the standards and guidelines encoded in the digital objects of the HIS. In addition, we outlined how digital objects enable visibility management practices and how these are related to control and accountability.

Our empirical focus contributes to prior research on the impact of technology on autonomy and control in the healthcare system. Recent studies in this field have often focused on the introduction of electronic patient records (e. g. Harper, O'Hara, Sellen & Duthie, 1997; Petrakaki et al., 2016). For example, Petrakaki et al. (2016) have shown that technology-based interventions enable new ways of working and collaborating, and in doing so redistribute work (and power) within and across professional boundaries, in particular between doctors, nurses and radiologists. Petrakaki at al. (2016) focus on the technology-afforded practices of record keeping, updating, consulting and sharing information, which changed after the implementation of electronic patient records in a hospital. In contrast, our empirical focus is on a HIS and mainly its OR-module. We argue that our observations are somewhat closer to actual medical work, as surgeons and others referred to the OR-module before, during and after surgeries. In this light, the impact of unexpected situations which shifted attention from the tool towards professional norms became clear.

Our empirical focus is closer to studies which explore the use of enterprise-wide healthcare systems (e. g. Bhattacherjee & Hikmet 2007; Melas et al., 2011). This body of literature, however, mostly deals with issues of technology acceptance during or after the introduction of a HIS and draws on theories that allow studying resistance or acceptance of new technologies. Our analysis is based on the notion of digital objects and the concept of visibility management which puts more emphasis on the role of visualizations and visual design in shaping professional control, autonomy and accountability. Based on this theoretical perspective, our empirical

findings have shown that sometimes control through digital objects is suspended and professional norms or other forms of communication (sometimes in a rough style) come to the fore. Future research may further investigate the boundary conditions for control through digital objects which we have started delineating.

Our analysis sheds new light on the role of digital objects by combining the four types of interaction that digital objects afford with the notion of visibility management practices. This combination contributes to previous research because it allows exploring the 'dark side' of digital objects. For example, our findings illustrate how digital objects are involved in micropolitics, claiming or refuting accountability, and in mutual surveillance. Considering visibility management practices advances previous research about the role of digital objects. Kallinikos and colleagues (2010, 2013), Leonardi and Treem (2012), as well as Faulkner and Runde (2013), hardly pay attention to the relationship between practices enabled by digital objects and issues of autonomy, control and accountability. Our study shows how practices such as editing information (e. g. changing surgery categorizations), prescribing work (e. g. via encoded standards and guidelines) as well as monitoring it (e. g. by representing ongoing and planned surgeries and distributing them among different professional groups), or reprogramming the underlying principles of the HIS (e. g. in favour of digital coercion) are related to autonomy, control and accountability. By specifically considering the visual design of digital objects, we revealed that some digital objects afforded simplification and the depersonalization of complex work. While we observed beneficial effects in our case, there may be situations where the reduction of complexity turns into overgeneralization (Gärtner & Huber, 2015). Further research may explore which design patterns afford what kind of interaction.

For professionals, contests over professional autonomy are often related to issues of identity regulation because the very question what it means being a professional is challenged if standards and guidelines overrule a 'clinician's prized autonomy' (Timmermans & Berg, 2003, p. 19). Our findings suggest that professionals gain their autonomy back when unexpected events occur. In these instances, professionals neglect the tool with its encoded standards and guidelines and mostly rely on face-to-face interactions. As other research has shown, clinicians are likely to draw on 'mindlines', i. e. internalised tacit guidelines, influenced by the opinions of their professional communities, rather than a rational assessment of evidence encoded in standards and guidelines (Gabbay & Le May, 2004). Unexpected events create distinctive challenges for coordination. Objects are seen as supporting coordination in such settings by enabling the emergent action needed to deal with a dynamic and uncertain process.

Moreover, our findings suggest that accountability is not only attained through formalized rules, as in the traditional control and coordination literature but can also be achieved in other ways, such as face-to-face discussions or meetings. This highlights that accountability can be created through informal and emergent action as

well as by formal means (Okhuysen & Bechky, 2009). It may also imply that identity-regulation is a matter of practices and praxis – the real doing (Reckwitz, 2002) – rather than a matter of having control over standards, guidelines, or other formal rule-systems that are encoded in IS. Advocates of standardization in health care work point out that standards are necessary to safeguard professional autonomy and exclusive expertise because they constitute a form of self-regulation: 'while third parties might try to enforce standards through sanctions, a distinguishing characteristic of standards is that, in comparison to laws and directives, they remain voluntary means of regulation' (Timmermans & Berg, 2003, p. 20f.). In this quote, Timmermans and Berg point to the informal side of standards which challenges the autonomy and identity of professionals but also provides professionals with the opportunity to regain the status as autonomous experts in negotiations about which guideline or standard to follow. In our findings, we highlighted the relationship between standards, different work conditions, and the struggle about autonomy, control and, therefore, identity-regulation. This puts more emphasis on standards that have already been voluntary implemented – but have to be constantly renegotiated in practice. As our findings show, the practice/praxis-modality of tone, voice and putting aside sentiments played a crucial role during negotiations, particularly in hot situations.

Our focus was on the non-material aspect of information systems. The point here is not so much about ontological differences between digital objects and material objects, but that digital objects are part of contemporary work life and are here to stay. Empirically, we saw that digital objects – like any kind of object – bring along specific properties which affect working life, such as distributed access to automatically updated information, certain rules being incorporated into the software in certain ways (e. g. surgery duration standard times) or the (im)practicalities of handling the personal computer. As mentioned in the literature review, we have seen a lot of research about the materiality of IS during the last decade, and we concede that our study is limited in this regard. Considering the role of material objects in visibility management practices and issues of autonomy, control and accountability seem to be a worthwhile research endeavour (cf. Rennstam, 2012). For example, access rights may not only vary between different people and places but also between different material devices such as personal computers, mobile phones, or workstations. This would imply to put more emphasis on the role of different IS in shaping autonomy and control for example. The benefit of the notion of digital objects is that they are conceptualized as being separate from their material bearers, i.e. they are decoupled from technological devices or information infrastructures (Yoo, Henfridsson & Lyytinen, 2010; Faulkner & Runde, 2013). Therefore, future research may draw on the concept of digital objects and explore the role of materiality at the same time.

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Appendix A: Exemplary Interview Questions

Note: The following shows a translation of the most important questions asked during interviews. The actual questions varied slightly to reflect the respondents' different organizational functions. All interviews were conducted in German.

Theme 1: General questions/warm-up

- What is your current job title and position?

- Which tasks do you work on?

- What prior experience and education do you have that are relevant for your current job?

Theme 2: Unexpected events – critical incidents

- Are unexpected events part of your daily work?
- If no, how would you explain this?
- If yes, please give an example of a recent unexpected event.
    - Please describe in detail who was involved and how the situation evolved
    - Please describe the result and what happened after the incident
- Please give an example for a situation in which an unexpected event was managed well/badly.
- How are unexpected events dealt with outside the OR?

Theme 3: The HIS/OR-module

- Which role does the HIS play in your daily work?
- Give an example of a concrete situation in which the HIS had impact on your work life.
- Which other actors use the HIS?
- What kind of information is captured by the HIS? For what purposes is this information used?
    - Is the HIS used to control you / your work? If so, in which way?
    - Does the HIS affect the degree to which you are held accountable for your work? If so, how?
- What do you need to know/do to use the HIS?
- What are negative impacts/unintended consequences of the HIS?
- Do you use the HIS in the case of unexpected events? If so, how? If not, why not?

Theme 4: Final questions

- How important are routines and standards for your work?
- What would you change/improve concerning the HIS?
- Is there something important which we missed with our questions?

Appendix B: Data structure and examples of codes

Abstracted themes	Combined codes	Examples of codes
Normal work: standardization and control	Control through prescription of standards	■ Emergency codification scheme used to prioritize surgeries in the OR-module ■ HIS offers documentation and monitoring of adherence to standards ■ Average duration of surgery set in OR-module
	Digital coercion	■ Confirmation clicks in pop-up window change 'Yes' and 'No' buttons, which forces staff to read the pop-up windows
	Colour-coding	■ Complexities of a surgery are translated into a red/green-symbol
Hot situations: Professional autonomy	Maintaining professional autonomy	■ Face-to-face communication overrules the HIS when unexpected events occur ■ Existing knowledge about the performance of individual surgeons cannot be fed into the system ■ The possibility to change the HIS quickly limits its reliability as predictor of future work times for surgeons
	Technical difficulties	■ The HIS is too slow and gets ignored during hot situations ■ Former HIS was perceived as superior
In general: Visibility management	Creation of visibility	■ Color-coding in OR-module shows which department has which slot in the OR ■ Additional, standardized information in mouse-over box ■ Time from first cut to completing the sealing of the wound (*Schnitt-Naht-Zeit*) as crucial indicator
	Medical care and accountability	■ Worst-case: surgery on the wrong patient or wrong leg must be avoided at all costs ■ The OR-module makes information on who does what transparent and available throughout the hospital
	Action at a distance	■ Representations replace personal contact ■ Daily morning meetings only address special cases / unexpected developments and rely on the HIS concerning all routine cases
	Diverging professional and digital accountability	■ Change in categorization as professional concern ■ Micro-political gaming around category changes