

Digital Innovation as Design of Digital Practice: Doctors as Designers in Healthcare

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Abstract

Medical professionals are increasingly assuming the role of maker and creator. At the same time, digital innovations, as part of evolving information infrastructures, are becoming increasingly prevalent in healthcare. In this paper, we adopt a Schönian approach to understand how a medical professional, who is not an IS designer by trade, engages in the design of digital practice — turning what may appear as a failed digital innovation effort into a successful design of digital practice. Our inquiry suggests three pragmatic principles that call for further investigation: (a) professionals can make a significant contribution to design work by inventing means for fact-based, reflective engagement with the situation; (b) the reorganization of work practice involves organizational design, information system design, and communication design; and (c) developing design as digital practice entails the development of fact-based design practice and must engage practical theories.

1. Introduction

It has recently been recognized that medical professionals must understand their work as makers and creators to adapt to the expectations arising around healthcare, many of which are fostered by digital innovation and the new media environment [1]. These concerns include the considerable interest in realizing patient centered care, precision medicine, and evidence based medicine that is predictive, preventive, personalized, and participatory [2, 3, 4]. It is argued here that this development cannot be confined to creating traditional medical diagnoses and procedures because medical professionals are implicated in the (re)design of practice for health and wellness with digital innovations [5, 6, 7]—that is, in the design of *digital practice*. When this happens, medical professionals are challenged to engage in the empirical and normative realities of incorporating (or not) digital

innovations into their practices [8, 9, 10, 11]. So, what does it mean for doctors to be designers?

In this paper, we align our thinking with ‘practice theory’ [12, 13] and argue that although digital products, architectures and service platforms are indeed at the core of digital innovation, these must be understood as embedded in digital practices. Such practices are the ‘nexuses of doing and saying’ [14] that are IT-enabled, recurrent and embodied in organized human action and interaction that is simultaneously material and enacted [13, 15]. Accordingly, the role of medical professionals in the design and enactment of digital practice cannot be seen in isolation from organizational context and the pragmatics of communication [16].

Digitalization of services in general has co-occurred with patient centered care through digital innovation in complicated, if not paradoxical, ways [8]. The potential of digital innovation, including openness, crowd, scale, participation, and personalization [2, 3, 4, 9] is not automatic nor is it guaranteed. Rather, it is a matter of design. It has long been argued that one should not assume that information technology (IT) is the solution as there might be organizational and communication issues that should rather be addressed [8]. Yet, most digital innovation research has focused on digital devices [17] product architecture [18, 19] and service platforms [20] rather than the complex ways that information infrastructures come together and evolve.

Hanseth and Lyytinen [21] defined “Information infrastructure” as a “shared, open (and unbounded), heterogeneous and evolving socio-technical system” or *installed base* composed of “IT capabilities and their user, operations and design communities.” They note that information infrastructures involve different classes of design, including IT capabilities, applications, platforms, and information infrastructure. Essentially, information infrastructures are systems of digital practices and modes of communication that emerge in relation to a particular set of technical artefacts [22, 23].

Design of infrastructure involves cultivating the installed base while promoting dynamic growth of the information infrastructure. However, neither information infrastructures nor digital practices can be

truly designed in a conventional sense since a designer cannot assume control over the design space [21]. Hanseth and Lyytinen point to episodes of design when different groups of designers become involved in, for instance, working out which IT capabilities are to be integrated and how or who has access to such capabilities. The key fact of information infrastructure design is that because there is an installed base there is no “design from scratch” [21]. Thus, design activity is always enmeshed in the evolution of a complex socio-technical system. This characterizes well the circumstances in which doctors as designers find themselves.

Hanseth and Lyytinen [21] used *design episodes* as a vehicle to articulate pertinent design principles for bootstrapping designs into play in complex systems and for adapting systems once they achieve uptake by multiple stakeholders. Here we turn attention to the emergence and realization of design episodes by professional practitioners who are not designers by trade but who step-up in challenging moments of the evolution of an information infrastructure to articulate and orchestrate an episode of design.

One of the co-authors of this paper, who is a doctor and head of unit at a hospital seeking to proactively incorporate digital innovations into its services, engaged in designing digital practice within an information infrastructure even though he was not a designer by trade. The hospital’s CEO had a vision for reorganizing the hospital around value based care and the utilization of digital innovations for that purpose. The hospital management charged the doctor to develop and implement an e-service for patients to schedule their own surgeries—that is, to self-schedule. The task was primarily framed as a technical question about how best to change the hospital’s website by connecting it to a scheduling database and making it available to patients. However, with a recent failed attempt by the hospital still fresh in memory, the doctor did not regard this as merely a technology project. Instead, the doctor recognized that the charge had serious implications for the installed base without presuming what these might necessarily be. In terms of infrastructure design, a design episode was emerging.

The doctor embarked on a collaborative inquiry into the scheduling process and the opportunities and consequences for pursuing the charge. By attending to these matters the doctor opened-up important organizational and communication issues that included the relationship to external actors, such as referring hospitals. In so doing, the doctor and his team opened up an episode of design in a particular way. Their actions offer important points of reflection for understanding design work for information infrastructures, and thus the design and enactment of

digital practices. Importantly, management’s originally envisioned e-service never materialized, which could be seen as a failure. Yet, the efforts of the design episode yielded substantial improvements in line with the management’s vision.

In what follows, we pursue what it means for a doctor to be a designer by focusing on a key challenge for understanding design relative to information infrastructures: how do practitioners, who are not designers by trade, come to recognize the design moments and then take designerly actions to address the problematic situation. To do this, we draw on insights from Schön’s design theory [24, 25] with the aim of identifying ways forward in understanding design for information infrastructures by reflecting on the articulation and orchestration of episodes for design that might as easily become moments of stalemate or conflict. A key insight from this reflection regards how practitioners can pursue fact-based design practice when design episodes are possible within an evolving information infrastructure.

2. Design Episodes and Design Practice

Donald Schön’s conceptualization of reflective practice is central to a broader theory of design that treats all professionals as designers doing design work [24, 25]. Schön’s approach to practice calls for appreciating the expertise practitioners hone through experience and reflection—practical theories—to make sense of problematic situations and craft solutions that manage the multiple competing demands of their circumstances [26]. Schön’s design theory is relevant for understanding design for information infrastructure.

First, Schön offers a broad view of what is designed and designable, which can range from the more traditional focus on physical products to the symbolic products, such as plans, policies, and diagnoses, that were often not considered in design theory.

Second, for Schön, the rationality of design is found in the iterative and reflective engagement with the situation, a “conversation with the situation,” [24] which is most pertinent when the options are not obvious and the problem is ill-defined. Schön emphasizes the importance of attending to design process and how the practitioner(s) manages a situation to turn it into design activity rather than just decision making (choosing among options), problem solving (finding a solution for a given problem), or impasse and conflict.

Third, for Schön “professional expertise not only entails technical knowledge but also judgment—that is, the artful competence of handling complexity, instability, and value-conflict when engaging people” [27]. He emphasizes the importance of frames in setting the problem and defining what solutions are actionable.

Frames link knowledge about what is with values about what ought to be. Frames are cognitive and discursive and evident in the artifacts of the technical-institutional settings of built environments [25].

These key premises of Schön's conceptualization of design come together by imagining what he refers to as the simplest case of design, such as a potter spinning clay into pots: A designer is in conversation with the materials by making substantive design moves that adjust materials toward intentions while these are met with the realities of what the materials can do and this results in the design object or modifications to the designer's intentions, knowledge, or tools. While design gains complexity as the object, intentions, tools, and materials become more complex, design seems to gain most complexity as those with a stake in design increase—users, sponsors, and designers—and become more differentiated.

A practitioner's expertise on this view, or for that matter a team of practitioners, is fully entangled with a developed capacity for recognizing design opportunity in complex situations. That expertise is essential in dealing with what Schön and Rein have called the "requirement of double designing," [25] which means that any substantive design move by designers must not threaten the integrity of the political and interpersonal dimensions of the coalition or community involved with the design. In complex settings such as policy development, inter-organizational operations, and technology implementation that Schön and Rein analyze, the design of the design process becomes crucial as multiple participants and stakeholders are involved and as each enacts particular ways of framing what counts as the problem in the situation and the solution.

Schön's design theory resonates well with Hanseth and Lyytinen's [21] theory of design for information infrastructure. Schön's perspective fully embraces the reality that design rarely starts from scratch. Not only does the built environment involve the installed base but it entails a complex web of resolutions and compromises to the differing frames in play in any complex socio-technical environment. Schön's design theory is a framework for discovering the particular practical theories of practitioners or teams. This includes the articulation of particular principles about creating particular design objects from the relevant materials, such as those put forward by Hanseth and Lyytinen regarding information infrastructure.

Schön's design theory also highlights a path for extending the design thinking of Hanseth and Lyytinen. They defined five design principles with 19 associated design rules to address the bootstrap problem (ie. innovation uptake when no users exist) and the adaptability problem (ie. sustaining an innovation as

user base diversifies). These principles and rules generally direct design attention the substantive design moves made that increase the likelihood of adoption and continued use—that is, to cultivate the installed base while promoting dynamic growth. These principles and rules offer significant insight into the requirement for double designing in complex systems. However, these principles are most useful once a design episode is underway and are not directed toward the process issues in articulating and orchestrating a design episode.

Schön's design theory offers a way forward for considering design principles for information infrastructure that take into account that design involves reflective conversations with the situation and design rationality. The potential for devising such principles is aided by Schön's framework which directs attention to the ways in which a designer, or design team, builds knowledge about the design setting and materials, while testing the operative framing in the situation. A practical theory of design can be articulated by attending to the design materials, design tools, and design thinking entailed in the work of the practitioner [5, 27].

3. Design Episodes: Reflecting on Operation Scheduling Changes

We have proposed in the prior section an integration of two complementary perspectives on design that theoretically address what it means for a doctor to be a designer of digital practice. This section illustrates the point drawing from the insights of one of the co-authors, who is a medical professional but not an information systems designer by trade who, found himself engaged in the design of digital practice as the HCSA, the Head of the Cardiothoracic Surgery and Anesthesia Unit (CSAU), at the Uppsala University Hospital (UUH) in Sweden. Section 3.1 describes the emergence of an episode for design in an evolving information infrastructure and the initial recognition that the episode could become a design episode. Section 3.2 describes the discovery of two in-situ principles for cultivating the installed base, along with methods that were developed to provide a fact-based means for reflecting on—having a conversation with—the situation.

3.1. From Paper Trails to Getting Digital: An Episode for Design Emerges

Uppsala University Hospital (UUH), founded in the 18th century, is a tertiary hospital in Sweden with approx. 8000 employees. The cardiothoracic surgery and anesthesia unit (CSAU) is a tertiary unit with 300 employees, including 40 physicians dealing with approximately 650 open heart surgeries, 400 lung

surgeries, and 600 other cases per year. The facilities consist of five operating rooms (OR), 14 thoracic intensive care (T-ICU) beds and 25 ward beds.

The CEO of the hospital, who began in 2011, expressed strong visions concerning availability of services and soon initiated a major reorganization of the hospital. A guiding principle for the new hospital management was the adoption of a value based approach, referred to as Value Based Care (VBC). The new CEO looked to international success stories as models for VBC at UUH. The CEO saw the Cleveland Clinic as an ideal model of a hospital adapting to the demands of the new media and healthcare context, including how they offered personalized scheduling for health services. In 2014, the new CEO challenged the heads of the departments, including the HCSA, to mimic the web interface of leading hospitals. This challenge surfaced the question whether self-scheduling of cardiac surgery could be possible through an e-service. While the prospect of more surgeries was of interest, the larger possibility envisioned by the CEO was the opportunity for the hospital at large to improve its engagement with patients. A key vehicle for this was a proposed redesign of the hospital's website that would enable more personalization of care for patients.

What the CEO envisioned was new. However, there was a history of effort in digitizing scheduling operations at UUH. In 2001, UHH began an investigation into the possibility of purchasing an electronic health record system (EHR). Up until then, all patient records had been managed manually. At the time, the primary care units in the region had local EHRs but the hospital did not. The aim was to find out if there was a system that would match the hospital's requirements. The license for a novel EHR was purchased in December 2003 and fully introduced at UUH in 2004, except for the surgical units because the EHR did not have a surgical operations scheduling module. Consequently, the surgical units continued with their paper based planning of surgeries.

In 2007, a database system was introduced to support OR scheduling. The implementation did not bring about any significant changes in operations planning as it was layered into the existing paper based workflow.

In the spring of 2013, a planning module called 'the OR module' was introduced into the EHR with the intention to replace database system. Even though CSAU's operation scheduling was functioning with Lotus Notes, the unit saw that using the OR module could have some benefits as it tracked each case from inception through invoicing. The EHR also offered some intelligence around the gathered data.

Subsequent to the implementation of the new planning module, CSAU ran the existing database

system in parallel with OR module. After a number of obstacles, the OR module implementation was paused and CSAU went back to using only the database system. In the summer of 2013, it was finally decided to cancel the OR module implementation and call it a failure. The call for cancellation thus came from the floor since staff could not fully appropriate the new planning module and refused to continue using two scheduling systems in parallel, which became very resource consuming. The subsequent post mortem suggested that the clinic did not adapt. Soon after the cancellation of the OR module implementation, the procurement of another scheduling system was initiated [28].

The HCSA thereby faced a problematic situation shaped by two converging demands: the failure of the OR module within a history of paper based scheduling and the new CEO's VBC Vision for reorganizing the hospital. While the CEO had a vision, the HCSA inherited the problem of digitizing a practice that had proven resistant to digitalization. There were many frames in conflict in the situation regarding the everyday routine on the floor, the value of computer supported scheduling, and ideas about what personalization actually involves. Whether this would become an episode of design was not obvious as it could have devolved into various forms of struggle among the stakeholders.

Triggered by the interest of more surgeries and the charge to personalize services, the HCSA and his staff realized that the workflow prior to the OR calendar needed more attention. This led to an introspective effort that was driven by a focus on the two alternative technical approaches rather than what it meant to enable self-scheduling. An episode for design was opened up when the HCSA and his staff began reflecting on a mundane, routine, and pervasive feature of health care services: the activity of scheduling. The design episode was underway when they began inquiry into the heart of the matter, which was a simple yet perplexing question that reframed the situation: Exactly what does it mean to self-schedule? A key factor identified was predictability, not only with implications for patients but also for doctors and other clinicians by means of choosing a surgeon, a specific OR, and the implications of cancellations and rescheduling. With this reframing, the team began to see how their local work practices related to scheduling and beyond – including the relationship to external actors such as referring hospitals. The team focused on how the CSAU actually handles scheduling and, consequently, how they could do their scheduling.

The design episode within the evolving information infrastructure happened when the HCSA's charge from the CEO shifted from a simple technical question of changing a database-driven website. This phase of

reflective inquiry by the HCSA and his team began by considering their own practice which generated a reframing of the problem and solutions in terms of organizational and communication design and not just technological design.

3.2. Conversing with the Situation: Discovering Fact Based Practice

By becoming more introspective about the workflow, the team increased their awareness of the intersection of organizational, information systems, and communication issues in operations scheduling. The team embarked on an inquiry that led to the discovery of two design principles for resolving the intersecting issues: (1) *Spacing*, which reimagined the use of time on the OR calendar and (2) *Left-Shifting*, which reimagined the handoff of patients from referring hospitals to the main regional hospital. Neither of these principles were obvious at the point in time where the team became more introspective about the workflow.

In fact, the HCSA developed several methods/techniques that helped make visible what had been largely invisible about organizational and communication issues in the surgery scheduling process. Indeed, these issues were often masked by the work-arounds the staff had developed to deal with the prior technological support for scheduling. The methods that enabled effective design thinking were organized around a principle of ‘dig where you stand,’ which is discussed in more detail in section 3.2.3. This was key as it enabled principled, disciplined creativity for the design thinking that led to the adoption of the concepts of spacing and left-shifting.

First, each design principle—spacing and left-shifting—is described to highlight how it resolved the intersecting issues among information systems, organization, and communication. Second, the underlying principle for managing design thinking—dig where you stand—is described to highlight the fact-based design techniques that were invented to manage the design thinking process. It was the “dig where you stand principle” that enabled the team to manage the requirement for double designing.

3.2.1. Scheduling Design Principle: Spacing. The introspection into the workflow was opened with an inquiry by the HCSA and his staff into how the operation time slots were assigned and used. They specifically focused on cardiac surgeries as a starting point. They found that there was capacity for 16 cardiac surgeries a week, which raised the question as to how many calls for patients should be made to make best use of the 16 available surgery slots in any given week? The surgeons and the coordinators were asked to estimate

their preferred number of patients called for surgery per week. It was discovered that while the surgeons tended to overbook or at least wanted to fill the OR schedule, the coordinators preferred fewer patient calls to reserve some space for the inevitable requests for rescheduling and emergency cases to come. This inquiry into the situation led to a reframing of the problem and its solution.

The given approach to scheduling filled the available operation slots for each week and distributed these sequentially starting with the first time on Monday morning and then the second and so on until all the slots were filled. Open slots were placed at the end of the week for scheduling flexibility. What happened, though, was that an unplanned surgery or complication would easily bump a case from a filled slot in the beginning of the week to an open one at the end. This, in turn, often implicated a change of surgeon and team, which was counterproductive in terms of quality and predictability. The issue of predictability became especially important for the idea of self-scheduling. The solution re-conceptualized the calendar for managing the OR. A principle of spacing was introduced that would spread operations throughout the week in a manner that preserved open slots in the OR each day so that last minute emergencies and other changes in priorities could be handled rather than delayed. The exploration of this solution was developed in a bottom-up manner by the coordinators and the surgeon responsible for prioritizing as supported by the HCSA.

3.2.2. Scheduling Design Principle: Left Shifting. The concept of spacing resolved some of the scheduling issues, but the team also had discovered that the information they received from the referring hospitals about each case was often incomplete. This would result in scheduling delays caused by the need for several rounds of clarification. The frustration caused by these delays led to further inquiry into the nature of ‘rescheduling.’

Because of the incomplete information, surgeries had been scheduled without fully knowing whether or not all the preconditions for having the surgery had been ultimately met and thus when the missing precondition was discovered (e.g. a particular investigation or a treatment such as dental work missing) then there would be a scramble to make it happen or a rescheduling would have to take place, potentially leading to unused slots. This kind of problem would also tend to reduce predictability and thereby hinder the introduction of self-scheduling in a future system.

Preliminary decisions to accept patients for surgery resulted in a need to add examinations such as x-ray in close proximity to the scheduled surgery. The confluence of scheduling and investigation also

impaired the accuracy in the process and decreased quality and predictability.

To resolve the newly framed problem, the team devised a principle of ‘left-shifting,’ which involved making sure that a patient’s profile and preparation was complete before being sent or that the necessary investigations and other preparatory treatments were complete before surgery/OR planning commences. The doctors were encouraged to summarize the investigations ahead of the decision (i.e. earlier or shifted to the left in the process). This led to further developments that separated the scheduling from investigations and other treatments as well as to refusing referrals that were not fully ready. The term ‘left shifting’ is derived from a pictorial representation of the referral process in which shifting activity left on a time-scale would free up time closer to the planned surgery, which provided additional space for preparation and ease of handling of emergency cases.

3.2.3. Designing Design Practice: Dig Where You Stand. In the case, the HCSA and the team came to terms with design materials, design tools, and design thinking entailed in developing a new approach for their circumstance. While technology and digitalization were central in generating change, the main invisible issues were about the organization and communication which, in turn, had implications for the IS artifacts embedded in the practice.

First, spacing was developed as the doctor, along with his associates, built a spreadsheet to analyze and stratify the reasons behind cancelled cases. This technique of problem-listing revealed that cancelled surgeries were only the starting point of opportunity for improving service and enabling eventual digitalization. This was caused by the imperative for medical prioritizing between scheduled cases, triggered by the lack of available slots in the schedule. The team concluded that offering a certain extent of free space in the schedule could improve flow and quality but also the predictability, which was an important factor both in the immediate situation as well as in the context of a future self-scheduling

Second, left-shifting was developed from an effort to improve information quality. The HCSA engaged specialists from UUH to communicate the conclusions on the left-shift requirements when visiting the referring hospitals in the region. In doing so, the unit further refined the reframing of the scheduling problem as a multi-stakeholder decision making process that required different specialists to gather and provide input to the surgeon who makes the final choice about readiness-for-surgery. What was especially significant with this reframing was that the entire team could see the

importance of the referring hospital to send patients in a state ready-for-surgery.

The discovery of spacing and left-shifting happened in part because of the fact-based design practice of the team that disciplined their creativity relative to the realities of the demands and opportunities afforded by the organization, communication, and information system. Both spacing and left-shifting were realized in large part by the underlying orientation of “dig where you stand” for designing design practice (i.e. the evidence is there right in front of you if you just start digging). Methods for representing the cross-cutting issues were developed that informed various small experiments with workflow organization, it was these principles that helped transform the episode into design for infrastructure.

4. Discussion

What does it mean for a doctor to be a designer? Within a broader disruptive context of the new media environment and digital innovation there is increasing demand and opportunity for realizing patient centered care, precision medicine, and evidence based medicine that is predictive, preventive, personalized, and participatory. The potential to harness digital innovation in healthcare, however, is neither automatic nor guaranteed. It is a matter of design. As such, organizational and communication issues, in addition to technological matters, are significant in realizing the potential of digital innovation in healthcare [8]. Although digital innovation research has recently begun to emphasize the importance of understanding the ecosystem in which digital innovation occurs [20, 29], the notion of digital practice, as a focal point for digital innovation, has not yet received much attention.

To address this, we have highlighted how, beyond the work of medical diagnosis, medical practitioners are implicated in the (re)design of practice for health and wellness with digital innovations. Moreover, designing digital practice challenges medical practitioners to engage in the empirical and normative realities of incorporating digital innovations into their practices. We have argued here that the digital design of practice can be usefully conceptualized by integrating theoretical insights about designing for information infrastructure [21] with theoretical insights about design practice in the work of professionals [24]. Doing so serves the purpose of theoretically framing what it means for a doctor to be a designer, while offering a way to integrate theoretical insights about design. We elaborated the argument with examples from a doctor’s experience of articulating and orchestrating a design episode within an evolving information infrastructure.

Within a long history of attempts to incorporate IT into practice, the HCSA and his team pursued a different path that neither irrationally accepted the CEO's technologically driven goal nor engaged in anti-rational rejection of the goal. Instead, the HCSA and his team embraced what Schön refers to as design rationality [24] by figuring out how to *dig-where-they-stood*. Central to this was the way in which the team became reflective about their own work practice, and the potential for digitalization by focusing on what it meant to self-schedule. That focus helped the team move past the technological imperative prevalent in the earlier efforts to implement new scheduling IT within the installed base of the hospital system, and to become increasingly aware of the web of intertwined issues regarding communication, organization, and IT in achieving the practice of scheduling. The innovations in practice that resulted were from concerted effort to *design* design practice – managing the requirements of double design. It was out of these methods that the substantive design moves of the team (e.g., left-shifting, spacing) emerged out of a reflective conversation with the situation (e.g., dig where you stand).

The perspective put forward here suggests that an improved understanding of the design of digital practice in healthcare must further account for three key tensions in design work around digital innovation in healthcare: (1) *the medical professional is not a trained designer but must be engaged in design*, (2) *design is not a singular activity but entails sometimes contradictory moments in the design space*, and (3) *design must engage both what-is and what-ought to be in order to discover what-is-possible*. These tensions invite rethinking digital innovation as design of digital practice.

The case furthermore suggests that the more general theory of designing for infrastructure can be enhanced by developing principles for design processes attentive to the requirement for double designing and methods for articulating and orchestrating design episodes within the evolution of information infrastructure. Three plausible pragmatic principles call for further investigation:

- First, professionals can make a significant contribution to design work by inventing means for fact-based, reflective engagement with the situation;
- Second, the reorganization of work practice is multidimensional as it involves organizational design, information system design, and communication design;
- Third, developing design as digital practice will entail the development of fact-based design practice and must engage practical theories of the designing group.

Future research may explore to what extent these principles answer the question of how a digital innovation failure, from a technology-deterministic vantage point, can be a fruitful starting point for a successful design of digital practice. Previous research has suggested that two self-reinforcing, generative mechanisms drive innovation in information infrastructures [29]: The 'innovation mechanism' suggests that new ideas for services are created by the space of possibilities afforded by the information infrastructure architecture and operations. The 'service mechanism' suggests that the more services an information infrastructure provides, the more value it offers, which attracts more users. The doctor's design moves suggest that information infrastructure innovation may also be driven by work practice redesign in response to external pressures and perceived limitations of the installed base. Although this observation does not contradict the two generative mechanisms, it provides grounds for further investigation of the interplay between digital practice and information infrastructure in developing practical design theory for digital innovation.

5. References

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