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RESEARCH

The Legacy of Coordinative Practice: How the Mesh of Formal and Informal Articulation Work Through Time Affects a Shipyard in Transition

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Abstract. This article explores the balance, and the shift in balance, between technologies and practices that coordinate work. The empirical data stems from a primarily qualitative study of a Norwegian shipyard in a phase of transition, where new models of collaboration emerge due to changes in the company environment. The article highlights the interplay between formal and informal articulation work, as well as the role of coordinative IT artifacts in this regard. With this background, the findings show that the balance (between coordinative technologies and practices) shifts depending on circumstances. Thus, the more formal coordination gains importance as transitions increases the need for detailed instructions. The findings also show that the existing IT infrastructure (the legacy) lacks the granularity as a coordinative artifact to facilitate necessary change in the organizational work arrangement, and how the workers cope with such issues. Based on this, the paper provides insights into how articulation work and its sociomaterial aspects develops over time in the interplay of organizational and technological change (or lack thereof).

Keywords: Articulation work, Coordination, Legacy, Maritime industry, Organization, Work practice

1 Introduction

Most forms of work are conducted with technology and tools. In modern workplaces, the tools for work execution are not only more advanced, but the work is also increasingly coordinated through different forms of technologies. In the current article we highlight the balance, and the shift in this balance, between the technologies that coordinate work and practices that coordinate work. We address this topic in an industrial setting, which raises some particular concerns

as the connection between these technologies and the practices might play out somewhat differently than in other work settings.

A distinguishing feature for industrial shop floor settings, in comparison with administrative and managerial ones, is the more peripherical role of computers as the tool and medium for work, causing coordination systems, like software managing workflow, to be at least partially external to tools and materials of work. That is, the work of a carpenter is mostly done with a hammer, saw and nails, not with the computer. Yet, the systems are important technologies for organizational ordering and accountability, for example to plan the design, keep track of what is done and what remains (Bowers, 1995). What Bowers et al. (1995) refer to as the second order nature of coordination systems, for task execution, actualizes how various forms of coordination take place to realize the work and control the workflow. These coordination practices are often referred to as 'articulation work' (Strauss, 1988).[1] The concept of articulation work is beneficial as it turns our attention to the concrete activities that must be accomplished to realize the more abstract concept of coordination. Articulation work is therefore central in our analysis.

The following research question is raised in this article: How does the legacy of coordination practice, sedimented into systems of coordination, affect (and how is it affected by) the interplay between formal and informal articulation work?

Technological and organizational developments within several industrial settings actualize the topic of coordination systems in a new way. The case study in this article is from the shipbuilding industry. Building a modern ship is a formidable task, both in terms of the advanced technical skills required in the individual disciplines and arguably even more so as a coordinative challenge of managing the complex dependencies between activities. The whole process of building a ship happens within a short timeframe where the workers cooperate to outfit the ship so it can be handed over to the customer at the due date. The case yard has started building a new type of vessel, while the composition of the workforce has also changed due to increased use of outsourcing. The study follows their existing processes of articulation work and discuss how they are challenged by these new developments.

Industry settings are an interesting case for discussing the relationship between work and its supporting technologies. Following Monteiro et al., (2013), the article goes beyond digital technologies as artefacts and focuses on their infrastructural aspects and how they support and connect the work processes at the shipyard. Increasingly, coordination is inscribed into information infrastructures, and coordinative work is thus "situated with infrastructures" (Almklov and Antonsen,

[1] See also Schmidt and Bannon (1992) and Suchman (1996)

2014; Monteiro et al., 2013). This brings attention to the sociomaterial nature of work, a term that refers to the co-evolution of practice and the technical systems through which work is conducted and how, consequently, the two become "inextricably entwined" (Østerlie et al., 2012, p. 93). Furthermore, it calls for studies of work to consider the sociomaterial nature of not only work execution but also the ways it is connected to such infrastructures.

Both the technological and organizational developments within the case put more emphasis on the role of coordination systems to instruct, coordinate and control work. A main finding in the article is a legacy within the systems of articulation work that develops over time. The study takes place in a situation where the legacy is actualized due to a transition in work context. Studying change processes such as these, furthermore, brings forth information regarding the aspects of *infrastructuring* of work that are taken for granted in the existing model. Parmiggiani et al. (2015) use the verb tense to capture the processual and even concurrent phases of technological developments in information infrastructure. The authors describe it as a generalization of articulation work and, with a reference to Bowers (1994), it is understood by the authors as a more roughly grained concept, highlighting "the constitutive role of invisible work and the necessary and non-heroic efforts of working-order technologies" (Ibid, p. 427). Studying a situation of significant change is thus not only interesting in itself. It also illuminates elements that have receded into the background (See Star and Ruhleder, 1996; Bowker and Star, 1999, p. 33ff) in the existing way of working. In the current article, the link between the legacy of previous practices and systems of coordination and the actors' ability to visualize and argue for needs in the new situation is highlighted.

The structure of the article is as follows. First, the empirical context of the case study is introduced. This contextual frame is key to understanding both its work processes and the significance of the identified changes. Next, the article explores the theoretical insights provided through the study of articulation work, and in particular computer-supported cooperative work. After outlining the methodological approach of the study, the empirical findings are presented. Through empirical examples, the dynamics between formal and informal articulation work is presented. In the following discussion, the implications of this dynamic over time are analyzed and discussed. The case shows how the technological infrastructure over time seems to co-evolve with the specifics of the work context. Although this embedded contextuality of the work setting is strengthening the systems' suitability for facilitating work performance, it also demonstrates how coordination systems define the articulation work in a manner that can be problematic, as the legacy within the systems reinforces established patterns of interaction and perceptions of work which, again, can hamper its ability to identify new emerging needs. Moreover, although workarounds can optimize the workflow in the here and now, our case shows the dangers of workarounds over time,

as this hampers the system's ability to identify weaknesses in how work is perceived, negotiated, and executed. In sum, we will show how coordinative work is sociomaterial, and that the sociomaterial legacy of previous coordinative practices implies a degree of inertia when the organization needs to change.

2 Empirical Context – Shipyards in Changing Markets

Our research project is geographically situated in the maritime cluster in the northwestern part of Norway. This regional maritime cluster consists of shipowners, shipbuilders, ship designers, and their specialized suppliers. It is thus home to a complete supply chain that has historically produced a variety of different vessels but has, over the last few decades, increasingly specialized in producing innovative and highly technologically advanced vessels for the offshore petroleum market. Analyses of this cluster identify regional commitment, and close dialogue and knowledge sharing within the cluster as central factors to its success. Strategies of innovation are described as socially interwoven and technologically collaborative, as well as possessing the ability to solve problems as they appear through formal and informal discussions across both internal and external organizational levels (e.g., Bjarnar et al., 2006; Bremnes, 2013; Halse and Bjarnar, 2014).

Another key characteristic of the shipbuilding industry in this region is their Engineer-To-Order (ETO) production strategy, which means that design, engineering, procurement, and production activities commence only after a customer order is confirmed (Powell et al., 2014). This approach entails active customer involvement in approving the drawings, material, and components that will be installed on the vessel (Kjersem et al., 2015). Moreover, an ETO strategy gives customer the opportunity to change and adapt parts and features of the final product during the whole project. Some of these changes are part of the flexibility desired by customers ordering offshore and cruise ships at Norwegian shipbuilding companies (Iakymenko et al., 2019).

Projects developed in this cluster also apply a certain level of concurrency among engineering, procurement, and production phases, which means that the physical production usually begins before the drawings are fully completed. This method is used to reduce the project duration even though it frequently implies re-work and adaptations of the final parts (Kjersem, 2020). Both the ETO approach and the concurrency among project phases are dependent on a good communication and coordination systems, where work is dynamically distributed among project participants (Kjersem, 2020). One of the systems used to facilitate such coordination is the planning software showing the work sequence and dependencies among disciplines, activities and tasks. The same system is also used for collecting reports and status of the works performed during the building process by both own and hired workers.

In recent years, the regional maritime industry described above has experienced several changes that have significant ramifications for the context in which its member yards operate. The first significant change concerns a shift in the business model, which throughout years of volatile markets has been developed to rely extensively on outsourcing of phases and activities to specialized suppliers. Like other European shipyards, shipbuilding companies in this region have developed a project execution strategy that involves many specialized suppliers delivering between 60–80% of the total value of the vessel. This approach requires considerable coordination between all entities involved in design, detail engineering, procurement, and production (Held, 2010). In terms of production, this approach means that shipyards depend on a large number of suppliers to either perform part of the work (fixed price) or supply extra workers (hourly engagement). Three implications of this business model are particularly notable. One is the increased need to coordinate activities across organizational boundaries. The second is that the contract becomes more important to define liabilities and areas of responsibility between the parties. The third is the changes in the workforce composition, which is now both temporary, as well as more culturally and organizationally mixed than previously.

The second change concerns an economic crisis, largely related to the fall in the oil price and reduced activity on the Norwegian continental shelf. The financial crisis in 2014 led to a slump in the offshore industry, escalating to a near collapse in the following years. The shipyards, which until then had relied heavily on this market, suddenly found themselves without new contracts and had to lay off many of their own employees.

The third interrelated change was a market reorientation, whereby cruise vessels became particularly important. This change had significant ramifications for competence requirements, priorities, and relationships. Although the regional yards had longstanding relationships with both shipowners and suppliers within the offshore sector, the market shift required the formation of new relationships with a different set of customers and suppliers. Throughout the years of close collaboration, offshore customers and the yard have developed a common language for shipbuilding based on an extended understanding of the vessel's purpose. A successful element in their relationship was a common interpretation of the yards position of negotiation throughout the duration of the whole project, with its continuous change orders from the customer side. This well-established negotiation position changed dramatically when the shipyards entered the cruise market, which required new competence and priorities. For example, whereas shipowners in the offshore sector were most concerned with the ships' functionality—as the ship was designed to perform demanding tasks in rough sea —the cruise sector had a much more passenger-oriented focus on interior, as this element is key to their competitive edge in the cruise industry. Consequently, the design and production of the accommodation and entertainment (interior) areas of the ship grew

dramatically in volume, complexity, and value for the customer. This therefore had a significant impact on the existing work processes.

These changes are interrelated and have real consequences for the scope of work on each project, affecting work processes, knowledge requirements, interactional patterns, and networks among workers. As such, it is important to discuss the relationship between technological infrastructure and professional practice, even more so because of the complex cooperative nature of shipbuilding. It is a particularly challenging environment to coordinate, as it requires multiple disciplines to work closely together in a limited space and within a limited timeframe. This is further complicated by the strong interdependencies between the tasks of the various disciplines that are often completed concurrently. All disciplines are interconnected, and they depend on each other to finish their own tasks, which often leads to rework (Grimsrud et al., 2005; Giskeødegård, 2015).

As practices and processes become established, they are routinized and thus their premises are taken for granted. Studying a phase of transition is potent because many of these taken for granted assumptions will necessarily resurface as topics for discussion. In the current case, the transition from building one type of vessel to another challenges the established professional cooperation as it implies new products, requirements, and actors. Thus, in a phase of transition, the infrastructure becomes more accessible for analysis as the relationship between work practice and the information systems meant to facilitate it becomes more articulated.

3 Coordinating Cooperative Industrial Work

Coordinating cooperative industrial work requires elements of both systematic and in situ coordination. In the following section of the article, we draw on existing literature to explore the meaning of both, their basis to mobilize actions, the sociomaterial context of enforcing set standards and the interdependent relationship between formal and informal coordination.

Cooperative work is constituted by interdependencies of actions done by the members of a common field of work. These interdependencies can have varying complexity (Schmidt and Simone, 2000). Coordination, defined by Malone and Crowston, 1994, p. 90) as '[…] managing dependencies between activities,' is vital for cooperative work to handle interdependencies between resources, sequence prerequisites, simultaneity constraints, and tasks (ibid). This is a particularly critical quality in the intense outfitting phase at a yard. However, to achieve cooperative work, continuous *articulation work* is necessary. Articulation work is a broader concept, which Strauss (1985) refers to as '[…] a kind of supra-type of work in any division of labor.' It includes the explicit and implicit 'specifics of putting together tasks, task sequences, task clusters, even aligning larger units of work and subprojects—in the service of work flow' (Strauss, 1988,

p. 164). Thus, it is essential to realize cooperative work (Schmidt, 2011). Arguably, one of the key contributions of CSCW in general, and the interest in "articulation work" in particular, is to highlight and flesh out the abstract phenomenon of coordination as a variety of sociomaterial practices.

Part of this ongoing articulation work are formal coordination artifacts and protocols, which enable specifications of properties of the result, interdependencies of tasks or objects, and protocols of interaction (Schmidt and Simone, 2000, p. 7). Formal here refers to specifications of processes, procedures or results that are intentionally designed by the company. Formal artifacts thus involve setting standards. Standards entail a point of reference to measure products or activities up against as it "is any set of agreed upon rules for the production of (textual or material) objects" (Bowker and Star, 1999). Standards thus work as a value infused point of reference to compare and evaluate objects or processes. Informal articulation work, on the other hand, relates to the members' continual effort to achieve mutual awareness that enables ad hoc alignment and improvisation during the actual execution of work (Schmidt and Simone, 2000). Informal articulation work becomes necessary as the descriptions of work are always representations of this work and can never capture everything that goes into executing a task in a given context (Gerson and Star, 1986; Suchman, 1987; 1995; Almklov and Antonsen, 2014).

To explore the scope, complexity and distributed nature of the building industry, Christensen's (2013) draws on Ingold's (2000) discussion of taskscapes – where each task takes at least part of its meaning through its position within an ensemble of task. Christensen argues that coordination artifacts, like Gantt charts, form and represent the common field of work in construction. To be able to do so, the details and sequences need to be abstracted to a manageable level. Artefacts like the chart serve as a point of reference for coordinative discussions in meetings between workers. Executing the work, however, filling out necessary details, requires a skilled practitioner. While Christensen demonstrates the critical role of articulation work to realize the construction phase, he nevertheless argues that the concept of articulation work does not fully cover coordinative practices in the building industry. According to Christensen the concept of articulation work implies something outside the task itself, that can be done prior, in parallel or after executing the task. Thus, articulation work that takes place with such coordinative artefacts in meetings are of second order nature. He proposes the concept of *intrinsic coordination* to capture a form of coordination he finds cannot be distinguished from the task itself. This is cooperative work in the sense that one individual reacts of the physical trace of other people's work (ibid). The emphasis on the specific characteristics of industrial work, is also found in Bowers et al., (1995, p. 52) as a distinction between workflow from within and workflow from without. The former refers to methods for achieving smooth workflow internal to work itself; and the latter, by methods other than those provided by the

work itself. They argue that, as industry work is not computational or informational in nature, the coordination system largely contributes to the latter.

However, the formal descriptions of tasks, sequences and results within coordination systems are formative for legitimate actions. Consequently, it is essential to understand the relationship between formal and informal dimensions. To understand the link between formal and informal articulation work, Suchman (1987) advises that we ask what role these representations have as resources for situated action. One way to do so is to approach technology supported work as dynamic 'sociomaterial configurations performed in practice,' as this can shed light on the entangled, emergent, and co-constitutive relationship of interaction between the involved actors, material, and social that together form the organization (Orlikowski, 2010, p. 136). Illustratively, Schmidt and Simone (2000) argue that the formal and informal articulation work over time become meshed through practice, whereby the dynamics of this formal and informal articulation seemingly stimulate a co-evolution of the information infrastructure.

Several strands of theory have emphasized the co-constitution and entanglement of practice and technology,[2] and the differences are primarily a matter and nuance and terminology.[3] Sociomaterial theory, as outlined by Orlikowski and Scott (2008), is particularly fruitful due to its weight on the emergence and inseparable co-evolution of the two. In our case, we show that the result of a history of co-evolution between the coordinating information infrastructures presents some challenges for the changes in practice necessitated by a transition to a new market. For computer-supported cooperative work (CSCW), this also responds to the call from Monteiro et al. (2013) for a transition to studying the entwinement with technology not only understood as artefacts in the context of practice but also as infrastructures connecting practice at different sites and points in time (see also Almklov and Antonsen, 2014).

Formal and informal articulation work take form within a certain organizational context. Andersen and Born (2000) direct our attention to the languages used in organization, and how these languages enable and constrain our imagination of what is expected of us but also what is possible. The language, moreover, defines the available codification of communication. Together, this affects our opportunities to both imagine and communicate organizational expectations and needs (Andersen and Born, 2000). In the discussion of technological infrastructure, the inertia of standards is often emphasized, as well as how suggesting alternatives requires an influential voice (Bowker and Star, 1999; Bush, 2011). Born and Anderson's attention to discourse is a reminder

[2] See Orlikowski and Scott (2008) for a discussion of a discussion of different "sociomaterial" research streams.

[3] See Kautz and Blegind Jensen (2012) for a refreshingly frustrated take on this questioning the usefulness of an exercise of continually finding nuances in the terminology.

of the conceptual space for imagination language creates and the subsequent codification of possible alternatives. As Bowker and Star's (1999) seminal work shows, classification schemes are by no means neutral and have consequences that define and legitimize certain worldviews while silencing others. Standards define the categories we can chose from, and thus communicate decisions done by someone else at a given time, though by whom, when, and where becomes less transparent when decisions are formed into task descriptions, product criteria, descriptions of interdependencies, or protocols of interaction. Returning to Christensen's (2013) use of Ingold's notion of taskscapes to illustrate to cooperatively complex nature of construction work, the point about organizational discourse is important. In this study the Gantt charts are shown to be a key artifact that shape and represent work. Hence, it also limits what claims and actions are viewed as legitimate. It leads to the questions of what happens to the infrastructures' ability to guide and coordinate work when the characteristics of work change significantly, as in the case where a shipyard moves from building one type of ship to another.

Here, the increased emphasis on formal articulation work in digital platforms is relevant. Much of the formal articulation work is done through the material infrastructure, frequently embedded in digital technology. To do so, work is split into different elements, and possible actions within the system are largely controlled by the embedded code (Aneesh, 2009). Digital technology does not only enable descriptions of work but also make it possible to define and enforce dependencies between different tasks. As companies increasingly use digital technology to support the execution and control of work, digitalization is becoming a catalyst that increases the level, importance, and power of standards as a mean to coordinate and control the execution of work. As such, it is much more potent than written procedures, as the code embedded in the system more actively enforces and monitors compliance (Almklov and Antonsen, 2019). As Almklov and Antonsen (2019) argue, digital systems allow a different kind of control of work, because the code limits the possible choices. The "tyranny of the drop-down menu" (ibid, p. 13) is the additional power afforded to standards, when they are inscribed in digital systems that guide work execution. As Bowker and Star (1999, p. 135) highlight, company software systems are in many senses "… frozen organizational and policy discourse."

The phenomenon of coordination is a variety of sociomaterial practices and requires continual articulation work to realize cooperative work. Articulation work has both formal and informal dimensions. These are interrelated as the formal procedures, standards, and systems are what Suchman (1987) refers to as resources for situated actions. These situated actions entail informal articulation work that coordinate and negotiate formal descriptions. The negotiations between formal and informal articulation work over time stimulate co-evolution of the information infrastructure (Schmidt and Simone, 2000). While doing so,

the activities are part of forming the organizational discourse, a term that refers to the role of the language has in enabling and constraining not only our ability to argue for identified needs, but also form our imagination of alternatives (Bowker and Star, 1999; Andersen and Born, 2000). As formal articulation artifacts are increasingly inscribed into digital infrastructure, their role shifts as the systems have more potential to enforce and monitor compliance (Almklov and Antonsen, 2019). The above discussion shows how industrial shop floor work adds another dimension to interplay between formal and informal articulation work, as much of the coordination cannot be distinguished from executing the task itself, and not only coordinating between tasks (Bowers et al., 1995; Christensen, 2013). This characteristic of industrial work positions the ship building industry as a particularly potent context to the entwinement with technologies as infrastructures connecting practice at different sites and points in time. An emphasis on the interplay between formal and informal articulation work enables a focus on the coordination systems' infrastructural aspects and how they support and connect the work processes at the shipyard.

4 Empirical Study

The article is based on empirical data collected at a Norwegian shipyard, as part of a three-year research project founded by the Norwegian research council. The project is a case study of the yards transition to cruise, that also includes the supplier of the ship's interior (both engineering and production) considering the substantial increase in significance of this discipline due to the shift to building cruise ships.

A case study is a research method that allows the researchers to explore a problem in depth, often using multiple methods. It allows a good understanding of the problem's contexts and processes as well as the causes of the studied phenomenon while fostering new hypotheses and research questions (Yin, 2014; Flyvbjerg, 2011). For the current study, the researchers combined qualitative data, with participant observation and a quantitative survey. Such triangulation in methods allows different perspectives on the same topic and is beneficial to ensure rigorous results when analyzing complex situations (Robson, 2011). The triangulation was not a balanced triangulation, understood as giving equal emphasis on the various data sources. In this article, only the background data from a larger survey is included. Thus, the survey is a supplementary source of data, giving an insight into the composition of the workforce that was not accessible through interviews or document analysis– both due to the number of workers, but also language. The following presentation presents choices made concerning these various data collections strategies.

The main source of data was semi-structured qualitative interviews. Candidates for the interviews were chosen from two ongoing shipbuilding projects for

the cruise market (with in-depth investigations into one of these). The selection of participants for the study included members of the project organization, both from the yard and the supplier in focus (interior). This selection aimed to capture the view of the project from different disciplines and roles. The data include 28 qualitative interviews (individual and group) with a total of 34 participants. The below table gives a detailed overview of their years of experience at the yard, position, duration of each interview and their acceptance to record the interview. Overall, the list of different roles and affiliations captures well the perspective on the project the research aimed to target (Table 1).

The list of interviews is ordered by the time the interview took place, and not by the principle of sorting the interviews by significance for the article's argument. While some interviews (like interview 11) were vital, it was the contrast

Table 1. List with the interviewees.

Nr	Years	Position	Duration	Audio
1	10	Engineering Machinery	1 h 15 min	Yes
2	6, 27	2 Senior Purchasers	1 h	Yes
3	11	Manager Electrical Eng	1 h	Yes
4	12	Principal engineer Interior Eng	1 h 30 min	Yes
5	14	Senior Engineering Hull	1 h	Yes
6	26	General Manager Electro/Production manager	1 h	Yes
7	13	Project Planner	1 h	Yes
8	17	Project Planner	1 h	No
9	11	Production coordinator HVAC	1 h	No
10	13	Ship Designer	1 h	Yes
11	13	Production coordinator Interior	1 h	Yes
12	34	Assistant Project Manager	1 h	No
13	30	Senior Engineer, Hull Engineering	1 h	Yes
14	30	Production coordinator Machine	1 h	Yes
15	28	Sen. Eng. Electrical Engineering	1 h	Yes
16	30	Technic Coordinator Electro at yard	1 h	Yes
17	13	Technic Coordinator Machine/piping	1 h	Yes
18	28	Technic Coordinator Interior	1 h	Yes
19	6	Supervisor at supplier of interior	1 h 30 min	Yes
20	29	Supervisor at supplier of interior	1 h 20 min	Yes
21	17	Supervisor at supplier of interior	1 h	Yes
22	33	Project Leader at supplier of interior	1 h	Yes
23	34	Engineering Director at supplier of interior	1 h 30 min	Yes
24	33	Purchasing Manager at supplier of interior	1 h	Yes
25	7	Project Manager at supplier of interior	1 h 30 min	Yes
26	-	4 Assistants Project Managers – on the same project	1 h	Yes
27	6	Site-Manager at supplier of interior	1 h	Yes
28	32	Project Leader at supplier of interior	1 h 15 min	Yes

between the way plans and coordination were discussed in the different disciplines that stimulated this understanding. Thus, making the totality of the interviews important. All interviews followed a semi-structured interview guide. The guide included questions about their background, work tasks, planning and coordination of work including what systems they used in their work, challenges they faced in their work, and opinions about digital assistance systems. The guide ensured that the interviews followed the same general structure but allowed the flow of the conversation to change which questions were asked and in what order. At the beginning of each interview a standardized introduction of the research project was presented. Some of the participants asked beforehand if they needed any extra material to bring to the meeting as support for their explanations. Consequently, the researchers were introduced to different planning- and communication software (e.g., Microsoft project planning and Synergi).

All interviews were conducted in Norwegian. The interviews were transcribed in full, and the transcriptions of interviews and meeting notes were uploaded to NVIVO. Two of the authors coded the material individually. One used the guide to categorize relevant information. The other used a more inductive approach, going through each of the transcripts identifying key words to each topic addressed in the transcript, independent of the guide. Afterwards, the two researchers met to discuss the coding and further analyze the data. All quotes used in the article is translated by the authors from Norwegian.

At the same time, two researchers conducted participant observation, following eight project meetings from the two building projects. The researchers attended foremen meetings, coordinators meetings and project management meetings. The researchers took notes during the meeting, on matters addressed as well as tone of meeting, communication patterns etc. These notes were written in full after the meetings.

As mentioned, the research team also did a quantitative survey as part of the project. This survey included questions on who the workers are, their opinions about coordination and communication, and their attitudes towards work in general and the potential of digital tools to help facilitate work. The larger survey is not included in this article, but some data providing background information concerning the workers' affiliation, experience, and so forth is mentioned. In addition, the results inform authors' interpretation of the other material. The survey targeted foremen, bas (middle level manager) and operators on the shop floor. The survey was distributed in the five most used languages at the yard. Participants were recruited through the foremen giving out a paper copy or an option to participant digitally (through a QR code). A final strategy (which also gave to best response), was to hand out a paper copy of the survey in the workers lunch hour at the yard cantina after giving information in Norwegian, English, and Polish about the survey. Based on the numbers provided by the yard, we estimated the population to consist of 820 people. Three hundred and sixteen responded,

and after cleaning the data 300 were left. This is a response rate of approximately 37 percent, which is an acceptable rate considering the immense work pressure the workers experienced during the period of the survey. The paper copies were registered digitally afterwards. Each 10th punching was rechecked against the original. The data was then uploaded and analyzed by using SPSS.

Studying the processes of coordination through different methods was critical to understand the issues at hand. The interviews gave insight into the work processes, the systems used by each company, and the implication of changes in type of vessel and workforce for these processes. The observations allowed an insight into coordination in situ, enabling an understanding of work practice, including articulation work. Finally, the quantitative survey allowed an insight into who the production workers are and what experience they bring with them into the yard. The project has been reported to the Norwegian Center for Research Data (NSD) and guidelines concerning consent and storage of personal data have been ensured.

5 Formal and Informal Coordination at the Yard

The outfitting phase of building a ship is highly intense and cooperatively complex. As the hull arrives, hundreds of workers, from multiple disciplines, need to be able to do their part of the job within the few months the yard has before delivery. These tasks are highly interdependent, and they are performed within the limited physical space of the vessel. The coming section of the article first gives a brief introduction to some of the coordinative dimensions one must tackle in shipbuilding. Next, two formal arenas for coordination that are in place to enable this work are presented– meetings and a coordination system meant to manage workflow. Articulation work concerns the interplay between formal and informal coordination. The following empirical section presents the use of these arenas in situ. The presentation focuses in particular on how established practices are challenged by new processes, new customers and more hired workers that have a more peripherical role in these processes. The legacy (technical and practical) of informal coordination work leads to issues in their current practices.

5.1 Coordinative Dimensions in Shipbuilding

Intensive man hours are engaged to outfit the ship within the set date of delivery– including steel (hull and steel outfitting), machinery and piping, HVAC (ventilation), electrical, accommodation, and surface, as well as scaffolding. Thus, the first coordinative dimension that must be managed is *sequence prerequisite*, particularly between engineering, who creates the drawings, and production, who uses these drawings to build the vessel. This type of sequence refers to which drawings must be delivered at each specific time. Another equally crucial

sequence dependency is managing the process of who does what at what time. This is vital because, for example, it is very difficult to install cables behind a painted wall without tearing it down and could result in re-work for several other disciplines. In fact, those two dimensions of sequence dependencies are highly interlinked in ETO projects due to the concurrency between the engineering, procurement, and production phases. Thus, managing task dependencies and sequence dependencies are particularly intertwined in shipbuilding. The limited time and space to do the job causes issues both related to managing shared resources and simultaneity constraints. This concerns both work from different disciplines that has to be done at the same time within a small physical space as well as the even more pressing issue of managing simultaneity constraints between different tasks that cannot be performed at the same time (the concurrency between 'hot work,' e.g., welding, and work that involves flammables is a typical example).Thus, achieving this complex coordination puts strict demands on the formal arenas of coordination, that are presented next.

5.2 Formal Articulation Work – Establishing Arenas for Coordination

This section focuses on two of the most central formal arenas for articulation of work – meetings and computer systems. These arenas are regarded as formal, as the adopted meeting structure and systems have an intentionally design role in the coordination process. In respect to the latter, the presentation will focus on the most central in terms of managing workflow in production, Synergi. The two arenas for formal articulation work are highly intertwined, as the activity list in Synergi was meant to be the basis for structuring the discussion in the observed project meetings (though at different levels of aggregation).

5.2.1 Meetings

Several of the yards in the region have adopted a meeting structure inspired by the Last Planner™ System (LPS) concept about ten years ago. LPS is a planning tool that underscores the importance of breaking the plan down into different levels of information-details. Part of the idea of this planning tool is to establish meetings dedicated to various levels of project planning – short term with a detailed focus to more long-term perspectives that are less detailed. The totality of these discussions is meant to ensure the plan's completion.

According to the previous manager for planning, the philosophy fits well with the regional yards' approach to planning, which was described as task oriented, whereby milestones measuring progress were a key focus. At the yard, this was translated into a three-level structure for planning meetings. First, a project plan meeting was dedicated to discussing issues regarding project status and to identifying solutions for problems at management level. This meeting included the project manager, dedicated coordinators (purchasing, technical, production) and the project planner. Second, they implemented a lookahead-planning meeting, aimed

at providing a perspective on project issues for the next five to eight weeks, and included discipline coordinators from several technical and production specializations as well as some of the most relevant sub-contractors. Third, a weekly production meeting, including own- and supplier's team leaders from all disciplines, was implemented to discuss production issues on coordinating workflow for the coming week. In addition, the yard frequently included a fourth level of meetings in their discussion of this meeting structure, which was a daily discipline specific stand-up "morning meeting" the yard initiated when the project was intensifying.

The idea behind the planning concept is to establish a meeting infrastructure of planning meetings providing systemic coordination, meant to enable in situ coordination. Although this is an arena for informal articulation work, it is formal in the sense that it is part of a material infrastructure meant to facilitate articulation work. As such, the meetings are understood as a coordinative artifact rather than a coordination protocol for two reasons. First, it specifies what type of discussion should be taken at what frequency, at what project level and with whom. Second, it provides an area to make "work work" in that it allows discussions of conflict, emerging issues and so forth with the workflow displayed in the coordination system Synergi as a point of reference. The meeting structure is further highly interrelated as at the various meeting levels all use different abstraction levels of the Synergi project plan as a point of reference for discussion.

5.2.2 Coordinative Technologies

The second arena for formal articulation work in production was a coordination system called Synergi. This software was used to formally allocate resources and coordinate work between the various disciplines, as well as a reporting platform. The basis for planning and budget was the scope of work specified in the contract. To make plans, the planners at the yard used a specific planning software – Primavera—whereby they would create a schedule, showing the dependencies, budget, and durations for each work package or activity. From this planning software, the planners exported an Excel document to the Synergi side, from which the plan was discussed during the planning meetings. Through Synergi, coordinators could sort out all the relevant activities for their specific scope of work and distribute available working hours between the chosen activity posts. As a result, Synergi helps visualize activities and the resources that each activity requires (Figure 1).

This screenshot presents one of the pages of activities displayed in the above described 'week plan meeting' for supervisors. The list written in English shows the type of task and the start and end date for all activities, as well as the disciplines involved. As a visualization tool, Synergi was very much a sequence-oriented coordinative tool.

In addition to the planning software and Synergi, the yard uses several 3D modelling software and parts of an ERP system, the purpose of which is to

Workspace

ID	Task/activity	Zone	Start	End	Discipline
2019-09	Week 09----------		2019-02-24	2019-03-03	292-Weeks
518563-04	Mounting Ceiling Galley no.4 D.8	83.4	2019-02-25	2019-04-12	SUB(ERP: 1020)
518563-06	Mounting Ceiling Galley no.6 D.9	84.4	2019-02-25	2019-04-12	SUB(ERP: 1020)
522581-01	Floor Public 1 D.6	81.2	2019-02-27	2019-06-14	SUB(ERP: 1020)
522581-04	Floor Public 4 D.7	82.2	2019-02-27	2019-06-14	SUB(ERP: 1020)
522581-02	Floor Public 2 D.6	81.3	2019-03-13	2019-06-14	SUB(ERP: 1020)
522581-05	Floor Public 5 D.7	82.3	2019-03-13	2019-06-14	SUB(ERP: 1020)
522581-07	Floor Public 7 D.8	83.3	2019-03-13	2019-06-14	SUB(ERP: 1020)
2019-13	Week 13----------		2019-03-24	2019-03-31	292-Weeks
522561-01	Floor Scullery no.1 D.7	82.2	2019-03-25	2019-06-07	SUB(ERP: 1020)
522561-02	Floor Galley/Pantry no.2 D.7	82.3	2019-03-25	2019-06-07	SUB(ERP: 1020)
522561-03	Floor Pantry/Scullery no.3 D.8	83.3	2019-03-25	2019-06-07	SUB(ERP: 1020)
522561-04	Floor Galley no.4 D.8	83.4	2019-03-25	2019-06-07	SUB(ERP: 1020)
522561-05	Floor Laundry no.5 D.9	84.2	2019-03-25	2019-06-07	SUB(ERP: 1020)
522561-06	Floor Galley no.6 D.9	84.4	2019-03-25	2019-06-07	SUB(ERP: 1020)
522581-03	Floor Public 3 D.6	81.4	2019-03-27	2019-06-14	SUB(ERP: 1020)
522581-06	Floor Public 6 D.7	82.4	2019-03-27	2019-06-14	SUB(ERP: 1020)
522581-08	Floor Public 8 D.8	83.4	2019-03-27	2019-06-14	SUB(ERP: 1020)
134350-70	Close Cut outs Zone 70	70	2019-04-03	2019-04-09	234(ERP: 1040)
2019-15	Week 15----------		2019-04-07	2019-04-14	292-Weeks
541504-00	Fixed Furniture Ttop/Deck 2 MVZ 4	10	2019-04-08	2019-05-10	223(ERP: 1020)
558800-E80	Laundry equipment MO	80	2019-04-10	2019-05-16	241(ERP: 1060)
2019-16	Week 16----------		2019-04-14	2019-04-21	292-Weeks
574802-40	HVAC ducts in Engine room 2	40	2019-04-22	2019-05-24	241(ERP: 1060)
541502-83	Fixed Furniture Deck 8 MVZ 2	83.2	2019-04-24	2019-06-14	223(ERP: 1020)
541502-84	Fixed Furniture Deck 9 MVZ 2	84.2	2019-04-24	2019-06-14	223(ERP: 1020)
541503-81	Fixed Furniture Deck 6 MVZ 3	81.3	2019-04-24	2019-06-14	223(ERP: 1020)
541503-82	Fixed Furniture Deck 7 MVZ 3	82.3	2019-04-24	2019-06-14	223(ERP: 1020)
541503-83	Fixed Furniture Deck 8 MVZ 3	83.3	2019-04-24	2019-06-14	223(ERP: 1020)
541503-84	Fixed Furniture Deck 9 MVZ 3	84.3	2019-04-24	2019-06-14	223(ERP: 1020)
541504-81	Fixed Furniture Deck 6 MVZ 4	81.4	2019-04-24	2019-06-14	223(ERP: 1020)
541504-82	Fixed Furniture Deck 7 MVZ 4	82.4	2019-04-24	2019-06-14	223(ERP: 1020)
541504-83	Fixed Furniture Deck 8 MVZ 4	83.4	2019-04-24	2019-06-14	223(ERP: 1020)

06.06.19 14:49:14

Figure. 1 Screenshot from Synergi, the software for sequence coordination, meant to illustrate both the logic of the system and issues with compliance.

collect information from all departments, including economy and finance. Consequently, most project participants work with a specific set of software tools in accordance with their role in the project (e.g., engineers use the 3D modelling, Excel, the ERP system, and the Synergi workspace). However, during the project meeting, it is only the Synergi template that is shown on the big screen.

5.3 Coordination and Control of the Work Process in situ

The following section discusses the role and significance of these formal arenas in realizing articulation work as defined by Strauss (1985). First, the introduction centers on how these arenas are put to use in coordinative discussions. Next, the presentation turns to how these formal arenas manage to enable necessary shifts in priorities due to changing needs created by the requirements of the new type of ship.

5.3.1 Managing Workflow

> The supervisors' meeting is held in a large room, with a long table seating approximately 40 people. The meeting is led by one of the Assistant Project Managers (AMP) and the project planner. The purpose of the meeting is to check the status of last week's activities as well as discuss the planned activities for the coming week, coordinate between departments, and replan activities when necessary. A projector displays information onto a canvas located at the short wall in the front of the room. The screen shows a page from the Synergi, which contains a long list of activities with information on starting and finishing dates as well as their status. Seated in the middle of the room, it is very difficult to read the text on the screen, as the font is quite small, and the canvas length is full of information. The planner comments that they have changed the way they visualize their activities from organizing the activities based on their end date to their starting date. Although this was a weekly meeting meant to discuss the coming week, the list had some activities with dates one month on. Many of the dates on the list had also already passed by a few days or weeks. "We'll start with the worst ones," says the project planner in Norwegian as she begins working through the list. She picks out an activity concerning a mast and starts inquiries into its progress. One of the supervisors replies that they will not be able to finish on time and will most likely need another week. The planner is about to change the date accordingly when one of the meeting participants in the front of the room makes a comment that it is difficult for those seated far away from the APM and planner to hear. The planner replies 'Yes, but if they cannot finish then…'.

The vignette is included to illustrate the interplay between formal and informal coordination. The screen shot from Synergi included above shows that although the production meeting for foremen was a weekly meeting, it included activities meant to be finished long before the meeting in June. The list was organized by start date, the earliest starting on the 13th of March and the last item on the list starting on the 12th of July. Furthermore, for an outsider it is somewhat unclear if there was a system for which activities were picked out and discussed, who the planner addressed her question to, who has the authority to decide on changes, and what is done when someone informs the planner of a delay. No one appeared to take note when dates were changed in the system. Interviews and informal conversations confirmed this observation, and indicated it was due to the expectation that they would change again. One of the interviewees from the interior supplier explained that he understood the dates within the system to be a form of guidance rather than directives and had more trouble understanding it as a working tool.

Considering the highly complex coordinative workspace, changes in one activity will affect multiple activities that cannot be performed until this activity is finished. Such dependency sometimes led to a discussion in the meeting in which other disciplines commented on how this change affected their work. Such discussions often triggered other topics. Regularly, these spontaneous discussions were about progress-critical matters. Even if these situations were quite often on critical issues they were not displayed in the list of activities (or even included in the minutes of the meeting) or decisively settled in the meeting. Hence, it was difficult to observe how these discussions were concluded and documented. An important reason for this is that the supervisors frequently agreed to talk after the meeting. This gave the impression that much of the decisions regarding work process and workflow were done in the "hallways." Illustrative of this was that many of the supervisors kept quiet during the "around the table" part of the meeting, where each supervisor could address relevant planning issues, only to address reasonably critical circumstances for their field later during the discussion of another activity. This strengthened the impression that this was not the main arena in which to address coordinative or planning issues.

The activity list from Synergi presented in the different meetings (weekly, five to eight weeks and project plan), was not restricted to the timeframe indicated by the planning levels. In all the meetings observed, informal ongoing coordination was prioritized, which both meant changing dates set in the system and raising issues concerning matters not on the list at all. It had become less about planning and more about coordination. Moreover, all levels of planning seemed to primarily focus on fairly current and detailed coordinative issues. In a conversation about this observation with the research team, one of the employees at the yard reflected that the focus on planning had faded into the background over time. The employee thought this related to the fact that the yard had been building similar offshore vessels over many years,

and consequently the planning aspect had gradually gone onto "autopilot." The employee, moreover, perceived the transition from a yard that also did steelwork (the hull) to one mainly focusing on outfitting as critical. This was believed to result in a less conscious relation to the activities. Furthermore, outfitting resulted in a mass start when the hull arrived at the yard, without a clear plan and structure of who goes first. In addition, the development within the planning division suggests that planning became less of a priority. From 2007 to 2015, the yard had a planning division consisting of a manager and four planners. In 2015, the yard had to downsize, and, in this process, the yard moved the manager into a position not related to planning and laid off one of the planners. The three remaining planners mostly worked individually on assigned projects and reported directly to the head of economy. This remained the practice at the yard until they got a new project director in 2018 who reinstated the position of planning manager.

5.4 Changing Conditions for Articulation Work

The observations and interviews indicated that informal articulation work was prioritized at the expense of more formal coordination. In the remaining part of this presentation, we discuss the ramifications of the identified contextual changes on this practice.

5.4.1 Changing Premises due to new Requirements for Cruise Vessels

With the transition to cruise, the interior part of the ship increased in terms of the importance, scale, and complexity of the project. One participant noted that the number of drawings related to the interior part of the ship had gone from 120 to 1200. The participants modified the number somewhat in the following conversation, but the statement speaks to the complexity as well as the increase in scale of the building process.

The change in scale had ramifications for the planning and coordination of work. One measure the yard took to address the new needs that came with building ships in a new segment was to establish a new position within engineering, one with a special competence for the interior. Although a new employee at the yard, the hired coordinator had extensive experience from the shipbuilding industry. According to this employee, the estimated budget and the planning of the whole project was too contextually bound to previous markets, as the budget set aside for interior did not account for its size or its new coordinative role in the project. This different type of ship affected the status and hierarchy between disciplines, whereby the interior went from being a small part of the ship (in terms of both workload and significance) to having a coordinative role, considering the emphasis on the interior as an attractive feature on cruise ships. As the interior coordinator commented:

> ‘Piping, HVAC that is ventilation, and cable, that is electro… and all of them shall have their place through the ship. And when it is a cruise ship with only interior, then they must cooperate with interior to get it [the work] done. And, when it is a cruise ship, no one wants large areas with technical things. It should be large areas they make money of… right? … to the passengers. So, this is incredibly important’

Sentiments expressed in other interviews also suggested an unfamiliarity with the new market, which created substantial challenges in all phases of the project. To illustrate, difficulties in understanding the ramifications of the signed scope of work during the sales process severely affected the conditions production was working under, as many of the premises were laid in this phase.

In the interviews, most of the discipline coordinators seemed content with the posts they had available through this template. Some even suggested there were too many activities, hindering the practical specification of work. At the same time, several of them acknowledged that the transition to cruise had created some unexpected activities for them, frequently including unfamiliar products and standards. The answers from the above-mentioned interior coordinator deviated from the apparent consensus among the other interviewees regarding the template. The coordinator explained that there were not nearly enough activities available in the template to be able to organize the interior work in its totality:

> ‘[…] and I do not have the activities I want. This is very important. Because plans are used to plan resources, and if I have a plan that goes like this, and another that goes like this… And here I sit with a mountain of tasks and no one to help me. Because I have no way to get it out’

The coordinator’s statement should be seen in light of the abovementioned frustration that the budget did not sufficiently consider the interior’s new role and significance. Considering that the plan lacked specificity in activities related to interior but rather had ‘lump’ categories, the coordinator found that it provided less of a ‘language’ to communicate the needs of this discipline. The legacy from previous types of ships causes a lack of granularity in the systems to coordinate interior. The coordinator was convinced that specified activities in the planning system that were relevant for the interior were vital to be able to visualize the need for resources. If the activities were too coarsely grained in the system, then it was difficult to explain why there was a need for more resources:

> ‘I cannot visualize… […] the need for resources. I cannot visualize this mountain that I cannot climb. It just becomes complaining, right?’

The coordinator seemed convinced that the planning software was a key tool for visualizing the need for resources by visualizing all the activities of her area of work. The coordinative role of the interior discipline is not only relevant in the engineering phase but also in the production process. This was further complicated by the fact that the interior work packages were mainly produced through a supplier. The yard representatives mentioned both capacity and competence as important reasons for this choice. The reliance on suppliers is another dimension that has to be explored in respect to articulation work, as the yard increasingly relies on outsourcing. This is discussed next.

5.4.2 Relational Changes Affecting Coordination and Control

In the beginning of this article, we highlighted the socially embedded regional maritime sector's innovation strategy as a defining feature. This is important in terms of articulation work because, traditionally, the yard has had long-term employees possessing extensive tacit knowledge regarding the yards' work processes as well as the regional industry. The close collaboration with the offshore suppliers led to a mutual understanding and trust-based relationship whereby problems were solved promptly through collaboration and agreement between people on the floor. Now, the constellations in production have changed, due to both the increased use of temporary workers and the need to dynamically upscale the workforce as the contracts started coming in and downscale after the project was completed. To illustrate this situation, 53.8 percent of the production workers and supervisors were permanent employees in 2014, but in 2019 the permanent workers only counted for 19.7 percent for this workforce.[4] Moreover, of the respondents to the survey, 40.7 percent were working at the yard for the very first time, a number that rises to 73.4 if extended to include those who had been there five times or less. However, the analysis shows that most of these workers had previous experience from other yards, nationally and internationally. Nevertheless, this means that many of the workers, permanent as well as temporary, had no prior work experience from the yard. Therefore, whereas most had experience within their professional field, many lacked contextual experiences of applying these skills in work processes at this specific yard. Moreover, the workers did not have the social relationships necessary for knowledge sharing. Consequently, more detailed and explicit work instructions became necessary.

[4] The numbers are derived from data provided by HR in connection with the estimation of the population for a survey conducted among production workers in 2014 and 2019. A potential source of error in the comparison is an uncertainty regarding whether or not the number from 2014 includes coordinators etc. associated with production. If so, the correct comparable number is 29.6 percent permanent staff in 2019, as the number given above only counts production workers and supervisors. Regardless, the difference between 2014 and 2019 shows a remarkable shift in balance. See Giskeødegård (2015) and Giskeødegård and Kjersem (2020) for an analysis of these surveys.

The need for a more detailed description of work is also related to how the contract is becoming more of a focal point for cooperation and coordination. Participants from the yard, as well as the supplier, describe a work reality whereby the relationships between the shipowner, yard, and suppliers are increasingly governed by very detailed contracts. The focus on contract affects work interaction on all levels, and several of the participants stressed that this was a defining change in the climate of cooperation:

> '…back then we could call the ship owner, right? If we had a problem, at least in the beginning, early start, we could call and get answers on different things. But now, you do not get nearly anything before you have signed the contract. Only the coarse features.'

Thus, the participants describe a significant change in the dialogue-oriented approach often described in the cluster analysis of the region. One of the suppliers attributed this change to an increased focus on liability caused by smaller margins in the business.

> '[…] it also has something to do with disclaimer of liability. That it is not on the drawing and then you hear it from those that do the job. We are squeezed by the yards, and we squeeze our suppliers. Yes, it is a vicious circle, but we build the boat together.'

Hence, the case shows that detailed descriptions of work become more important due to changes in relationships—both on the production and contractual level. Workers do not have the same pre-knowledge of the yard, and therefore require more explicit instructions, and the contract becomes a more important point of reference in defining the scope of work—including responsibilities. At the same time, it is more difficult to define the scope as well as outline specific details, because many of the cruise-specific elements are unfamiliar to the yard and most of its workers. More complexity factors are added by the changes required by the customer throughout the whole project as part of the ETO approach.

In short, the empirical examples show that the yard has an established practice of informally settling coordinative issues as they appear, somewhat unrelated to the sequence requirements from the formal arenas in place for coordination. This is in large a result of having produced the same type of ship for many years, in a work context that is not particularly sequential in nature. The trust and shared understanding of the market has allowed the yard to find solutions to problems when they appear. Yet, building a new type of ship which means new customers, suppliers, products and requirements causes unfamiliar processes and uncertainties in terms of prioritization. This is amplified by

many new workers that would need more detailed instructions. The empirical case shows that the formal documents and processes face challenges to facilitate these new requirements and situational conditions. The following discussion reflects on the implication of these changes for articulation work.

6 Discussion

The above empirical presentation has centered on arenas and practices of articulation work, and how the established practices have been challenged due to key contextual changes. This section of the article analyzes the implication of the data presented. It largely follows the structure of chapter five, by first discussing the formal arena, their use in practice, and then the contextual changes.

6.1 The Role of Formal Arenas of Articulation Work as Resources of Situated Actions

The current case shows how the formal articulation work provides a systemic form of coordination for cooperative work. Since cooperative work is constituted by interdependencies of actions, establishing formal arenas to facilitate articulation work becomes essential (Strauss, 1988; Schmidt and Simone, 2000; Schmidt, 2011). A valuable insight from this empirical case is the interdependent, sociomaterial relationship between formal and informal articulation work. These two different forms of articulation work do mesh over time (Schmidt and Simone, 2000). In this case, this is evident when the disciplines strongly related to the offshore petroleum market find the coordination systems finely tuned to their needs, while interior does not. Yet, a critical point in the current case is that the role of these formal arenas changes as the yard gains experience with the work processes these systems support. Over time, they become less of a resource for situated actions as informal articulation work is favored. This affects the "mesh" of formal and informal articulation work within the coordination systems over time.

The arenas for formal articulation work presented in this article are formative for systemic coordination. The contract, budget, and the scope of work will define the project plan in the planning software. This software is connected to the coordination system Synergi, which serves as a platform for the dissemination of project information among project participants, including relevant suppliers. The template within Synergi, which provides a list of possible activities the coordinator can choose from and distribute to the available resources, is illustrative of how formal articulation work done on digital platforms means breaking work into pieces and establishing standard descriptions of work. Thus, work is coded into the system (Aneesh, 2009). Software like Synergi are key artifacts that help form and represent work (Christensen, 2013).

Two of the formal arenas for articulation work are presented in detail, the meeting structure, and the computer system, Synergi. According to Schmidt and Simone (2000) formal coordinative artifacts enable specifications of properties of the result, interdependencies of tasks or objects, and protocols of interaction. In sum, it represents a top-down approach to planning and coordination, whereby the management at the yard appeared to see the planning structure and the computer software structured in a sequence-oriented coordinative approach to production.

These formative coordination systems are sociomaterial in nature. Formal articulation work relies on informal articulation work for the tasks to be realized. As pointed out by Christensen (2013) systems like Synergi provide abstract representations, that rely on skilled practitioners to fill in the missing pieces. This is particularly true in industrial settings, where the tools and materials to execute the task are to a large extent other than the those provided by the coordination systems (Bowers et al., 1995). In the words of Suchman (1987) plans are resources for situated actions. The mesh of formal and informal articulation work over time suggests a co-evolution where coordination systems over time incorporates context of practice. The work environment is then understood as a socio-technological system of co-constitutive relationships (Orlikowski and Scott, 2008; Orlikowski, 2010). In this case, the meshing of formal and informal articulation work over time is illustrated through how the coordinators and foremen from disciplines that had a strong position in offshore find the activities they must choose from in the planning system to be adequate or even too fine grained. This seems to suggest a refinement of the necessary differentiation over time. In short, one can find a legacy within the system of coordination over time, that is specifically attuned to needs emerging through practice. In this case, building offshore vessels.

However, the article highlights the balance between formal and informal articulation work by showing how formal coordination systems fade into the background as the yard gain experience in the processes the systems facilitate. This backgrounding of formal systems, as experience grows, also led them to being less updated. As the yard started producing new types of vessels this co-evolved balance is disturbed. This imbalance affects the mesh between formal and informal coordinative practices.

A key theoretical point in this paper is thus, that articulation work in industrial settings is always a blend of formal coordination systems and informal articulation work, and that this will develop over time. In our case this blend is disturbed, necessitating a redistribution of how these are organized.

The case shows that the professional practitioners' assessment is given considerable weight in the estimation of work processes, up to the point where the participants seem to largely ignore the dates provided by the system, as they changed them according to expressed needs and expected them to change

again if necessary. Thus, the plan in Synergi was not defining the work process. Our interviews indicate that much of the articulation work is done as issues appear, and not brought into these formal meeting arenas. Similarly, the planning meetings had all turned into arenas for the coordination of current issues, largely ignoring the intended purpose of the meeting. These findings show that the planning meetings had drifted away from the originally intended structure—both in terms of level of discussion and form. A reason for the latter could quite possibly be the unfamiliar processes in cruise, in a period of rapid upscaling, that led to a great deal of necessary firefighting. However, the interviews seem to support that this emphasis on informal articulation predates building new ships.

Hence, the formal articulation work had faded at the expense of the informal, deprioritizing the importance of updating/using the technological infrastructure as a working tool. This can partly be understood in relation to the special character of industrial work, emphasized by both Christensen (2013) and Bowers et al. (1995). The latter argues that coordinative software is at least in part second order to the tools of working. Whereas the processes incorporate aspects from informal articulation work into formal arenas over time, the case also shows that this does not necessarily mesh formal and informal articulation work. Returning to the concepts of workflow from within (workflow achieved by methods internal to the actual work) vs. workflow from without (through methods external to that required to do the actual task), the coordination system and other arenas for formal articulation work appear related to workflow from without. Emphasis on articulation work related to workflow from within seem to have been prioritized over time in a manner that has pushed the formal arenas into the background, ultimately hampering the formal arena's ability to organize for the necessary articulation work.

These legacies within the system, along with a prioritization of informal articulation work, are actualized when the yard experience significant changes on several levels. While successful infrastructure fades into the background (Bowker and Star, 1999), this change to another ship type foregrounded some of the ways of taken-for-granted ways of organizing work.

6.2 Changes in Context and its Implications for Articulation Work

The case shows that with experience, the coordination systems fade into the background, as informal articulation work is prioritized. Yet, with cruise ships, the unfamiliarity increases, which revitalizes the importance of the coordination systems. Also, new requirements challenge implicit patterns of hierarchy and authority in the informal articulation work.

The coordination systems regain importance with unfamiliar processes. There are several drivers of an increased emphasis on formal articulation work in this change. First, the increased reliance on outsourcing strategies, as well as the

recent re-staffing after new contracts came in, caused a dramatic change in the workers' specific competences. Second, the change in market has resulted in unfamiliar work tasks as well as work processes for the workers. Third, we can observe a relational change, as the participants underscored the enhanced emphasis on the contract as a governing interaction between the ship owner, the yard, and its suppliers. All these changes suggest that relying on skilled practitioners to fill in the gaps, like Christensen (2013) emphasize the importance of, become far more challenging. The preceding section shows the emphasis on informal articulation work.

There are several reasons in the context of significant change to why this becomes problematic. The composition of the workers shows that they have much less yard-specific experience. From a practice perspective, this will be highly significant in terms of realizing informal articulation work. Moreover, new requirements challenge established patterns of hierarchy and authority in the informal articulation work. The unfamiliarity that came with new customers, and new requirements and processes in new markets, was amplified by the manner in which this change most likely challenged the established practices of who should be given priority in coordination conflicts. Informal articulation work refers to mutual awareness to enable ad hoc alignments and improvisation during the actual work (Schmidt and Simone, 2000). One pressing issue in this respect is established informal hierarchies and status between disciplines when one moves from building ships where the ships' ability to handle rough offshore operations (thus increasing the emphasis on machinery etc.) to a ship where the interior is critical. This is further complicated using suppliers to deliver the interior part of the vessel. Not only is the position of the discipline altered, but the ones that need to convince the others of their significance are largely external to the established organizational hierarchy. The shift in priorities between disciplines further put weight on formal coordinative artifacts and emphasize their ability to accurately capture and represent the needs of the common field of work.

Though our focus here is on geographically co-located work in an industrial context, there are parallels to be drawn to project coordination more broadly, in other contexts and also of a distributed nature. For example, there is a research strand on how offshoring of software development introduces coordinative challenges and re-negotiations of the coordinative legacy similar to those reported here (e.g. Boden et al., 2012; Bjørn et al., 2014). Though the causes of the renegotiation of coordination in these cases are different than in our case, distance and cultural differences being important factors, there are similarities in the fact that one needs to reassess the mesh of formal and informal coordination.

In summary, new unfamiliar requirements increase the need for explicit instructions. However, the unfamiliarity also complicates representations within the systems, which creates a paradox. This is discussed next.

6.2.1 The Coordination Systems' Ability to Represent Work and Capture Emerging Needs

Less familiarity requires more detailed instructions. As such, digital systems become more important. As argued by Almklov and Antonsen (2019) coordination systems embedded in digital infrastructure are more potent than written procedures as they provide a more active form of enforcing and monitoring compliance. Regarding this point, the second order of such system in regard to performing work in industry settings is a critical element (Bowers et al., 1995). Nevertheless, the systems form and represent the common field of work. Also, the shipbuilding industry is currently exploring digital assistance tools that will have more direct influence on production. As such, information systems' ability to describe and facilitate work in an appropriate manner becomes critical. This actualizes the described changes, and whether the representations embedded in the digitally embedded coordination systems are able to identify and describe work processes in an appropriate manner.

Platforms for formal articulation work consist of standards, and standards entail representations of work (Suchman, 1987; 1995; Bowker and Star, 1999; Almklov and Antonsen, 2019). Although such representations will never be able to capture all aspects of performing a work task, such representations are nevertheless of varying quality, depending on the designers' in-depth understanding of the work practice they seek to represent. Therefore, the change from building offshore vessels to cruise ships results in a paradox; whereas such platforms for formal articulation work become more important, the representations become more difficult to get sufficiently precise, as the yard lacks the necessary experience of building cruise ships. This challenge is further enhanced by the ETO production strategy, where the customer is involved and can frequently challenge current solutions well into the production processes. The short time frame in shipbuilding projects further increases this challenge, as it creates a high level of concurrency between the engineering and building phase of the project. The project participants argued that this has worsened with the new market, as shipyards were desperate to sign new contracts and allowed the customer to push them too far concerning the budget and the delivery date, further escalated by delays due to unfamiliar processes.

6.2.2 The Systems Role in Organizational Discourse

The case shows that over time the coordination systems faded into the background, but that their importance was revitalized when changing from offshore to cruise. When re-actualized, it becomes evident that the coordination systems are important to identify, visualize and argue for resources and needs. Here, the legacy from offshore which is a result of the "mesh" of informal and formal articulation work hampers the coordination systems ability to support new processes.

Bowker and Star's (1999) reminds us that classifications define and legitimate certain world views while silencing others. Suggesting alternatives to the set

standard will necessarily require an influential voice (Busch, 2000; Bush, 2011). This is of upmost importance for a discussion of coordination systems. Technological infrastructure becomes a powerful part of the organizational discourse, shaping spaces of imagination as well as enabling and constricting choices (Andersen and Born, 2000; Bowker and Star, 1999). As we have argued, digital technology enables not only standardized descriptions of work but defines and enforces interdependencies in a much more potent and depersonalized manner than written procedures (Bowker and Star, 1999; Almklov and Antonsen, 2019). Thus, what we might call the "digital discourse of work" becomes more important with the increased use of digital technology, the code embedded in the technology limiting the available options.

As Suchman (1995) has shown us, representation serves interests, thus there is a link between visibility and power. The technology's significance for the discipline coordinators' possibility to visualize, and argue for, their need for resources and prioritization is most clearly illustrated by the coordinator from interior, who was convinced that the lack of representation of the interior part of the work within the system was causing problems for the discipline, and that digital representations (in the sense of appropriate activities) were crucial for the ability to both be able to plan her job or visualize the need for extra resources. It is a powerful example of the power of organizational discourse, as she states that without such activity specifications, her argument for more resources becomes "complaining". Thus, diminishing the validity of her claim to resources. The relevance of discourse is also shown in how the other coordinators from more established disciplines find the available activities satisfactory or even too fine-grained. This suggests there has been a co-evolution between work processes and this technological infrastructure over time before the transition to building new vessels. The yard has been involved in the offshore market for a long time and, most likely, activities have been evaluated and revised over these years.

This example illustrates what we see as established patterns of hierarchy and status within the work group, i.e., who has the final say in a negotiation of priorities. The problem was reinforced by the established practice at the yard, where critical decisions were taken through informal articulation work.

The empirical case shows that although the system is not formative of work processes (i.e., the workers prioritization of informal articulation), the digital discourse it represents still very much limits the available choices and the space for imagination of the alternatives. Hence, the example underscores the role of technological infrastructure for the organizational discourse, as the technology is central to defining the premises upon which claims can be made. The case shows how the legacy is hampering the transition to cruise. The ability to argue needs and negotiate resources becomes particularly important in the context of market change as the role of the discipline changed. However, as the interviewees

expressed, the market change affected all disciplines. There were unfamiliar products, work processes, and standards. Although the other participants did not currently recognize the need for new categories of activities to help organize work, it is likely such needs will emerge over time given their recognition of new tasks. Thus, supporting the significance of digital information infrastructure to enforce and control standards set by an organization (Bowker and Star, 1999; Almklov and Antonsen, 2019). As the contextual changes meant more emphasis on the information systems role to instruct work, this strengthens its role as an "enforcer" of company policies. The problem occurs the legacy within coordination systems are not equipped to tackle significant change.

7 Conclusions – the Legacy of Co-Evolution

The main question in this article concerns the impact of the legacy of coordinative practice over time. More specifically, how it affects formal and informal articulation work.

The empirical data of the case shows several arenas for formal articulation work that are formative for how coordination processes take form over time. These coordination systems provided the yard employees with a sequence-oriented structure to coordination. Over time, formal and informal processes of articulation work meshed, fine-tuning and adjusting the coordination systems to contextual needs related to the offshore industry they were in. Yet, as the yard gained experience, informal articulation work was prioritized up to a point that the coordination systems faded into the background. When their value as a resource became less prioritized, the emphasis on keeping them updated was reduced. Changing from offshore to cruise ships caused a degree of unfamiliarity that revitalized the significance of the coordination systems. At that point, it became apparent that the emphasis on informal articulation over time, as well as the legacy in the coordination systems, hampered their ability to facilitate necessary change.

In the literature on articulation work, the focus is often on its role in realizing work in here and now. Thus, it typically highlights the practical adjustments done in concrete situations necessary to ensure smooth operations. This article analyzes articulation work as a sociomaterial mix of technical systems and improvisations and shows that these co-develop over time. The legacy of this co-evolution leads to inertia when major changes are necessary, as it is then formative for the ability to identify, visualize and argue for emerging coordinative needs. Employing a sociomaterial perspective on articulation work highlights the interplay between practice and coordinative systems, and moreover, it enables an analysis of articulation work as an evolving process.

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The third author has been central in analysis of the data, as well as drafting and critically revising the text.

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Ethical Approval The project has outlined a data management plan that has been evaluated and approved by the Norwegian centre for research data AS (Now Norwegian Agency for shared services in education and research, now SIKT).

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