Cross-Workplace Perspectives: Relating studies from hospitals to an oil and gas workplace

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ABSTRACT
This discussion paper highlights how two apparently contrasting professions - an oil and gas refinery operator and a hospital nurse - share similar properties in how they collaborate, communicate and use artifacts. We relate literature on the nursing and hospital contexts with observations and data from our own workplace study at a refinery in Norway. In doing so, we seek to provide an introduction to a context that is not often encountered in CSCW or CHI literature, through the lens of the more familiar hospital setting.

Categories and Subject Descriptors
K.4.3 **[Computers and society]**: Organizational Issues – *Computer-Supported Collaborative Work*

General Terms
Design, Human Factors

Keywords
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1. INTRODUCTION
At first glance, a gas refinery has little in common with a hospital. A gas refinery conjures imagery of a sprawling outdoor pipe-labyrinth of interconnected furnaces, high-pressure tanks and noisy pumps. Think of a hospital ward however, and perhaps the image of clean, sparse rooms with patients attended to by nurses dressed in white comes to mind.

While the physical environment for each domain is quite different, the nature of the work has many similarities. In the refinery, operators walk around the plant doing manual 'rounds', taking measurements and looking for indicators of damage or malfunction which automated instruments may not pick up. The operator's role is a sensorial one in which he (or she) develops an intimate 'feeling' for the plant. All their senses are used, such as smelling for oil leaks, listening for rattles, feeling vibrations and so on. Even in cold conditions, operators commonly take off a glove to feel the heat and vibration from rotating machinery, to get a qualitative sense of how it is running. Likewise, nurses perform similar tasks to an operator: observation rounds, taking measurements, making adjustments, performing small procedures. For both the nurse and the operator, their 'patients' are often wired up to sensing equipment which can log changes in values and raise alarms, however neither can trust automation completely – manual rounds are still an important part of their jobs.

There are also similarities in the roles and relationships between nurses and doctors, operators and engineers. Through a functionalist approach the nurses' subordinate position is explained through their relative unimportance in the division of labour as a doctor's knowledge and skills are harder to achieve than the knowledge and skills of a nurse. This relationship is somewhat analogous to the operators and engineers, as both doctors and engineers possess expert power in their field [4]. Doctors have the right to prescribe a course of treatment, and monitor its progress by way of data and observations collected by the nursing staff. Doctors might also bring in specialists to provide additional services and expertise, such as x-ray technicians and physiotherapists. Contact with patients is more limited, much of it mediated through nurses. At the refinery, engineers are responsible for particular plant systems, and have their own areas of expertise. Engineers examine long-term trends and make diagnoses of issues reported by operators. They may come up with a response plan, which is carried out by operators, often in conjunction contractors or suppliers. In the mornings, engineers will often visit the central control room, look over process information and discuss issues with operators, but otherwise spend the bulk of their time in their offices or meetings. When a problem occurs with 'their' part of the plant, the engineer is called down to the control room to investigate; each engineer is also issued with an emergency phone so they are contactable after-hours. Expert doctors can service multiple hospitals, perhaps even remotely [7]. Likewise, the oil and gas industry is moving towards having engineers service multiple plants, with an emphasis on remote working.

Both medical and oil and gas (O&G) organisations share similar concerns for safety and security. Hospitals are concerned with radio interference with medical equipment, and the O&G industry has very stringent requirements for safety in combustible atmospheres. Confidentiality and integrity of records and data transmissions is vital for both organisations. These shared requirements place stringent demands on potential solutions, particularly those involving mobility and wireless communication. This is of import as workers in both scenarios are quite mobile, particularly nurses and operators.

Operators, like nurses, have a uniform which strongly links them to their role and Goffmanesque 'front'. Except for those on control room duty, operators wear bright orange, flame-retardant suits, steel-capped boots with a radio hanging from their belt. Engineers, however, like most doctors, only don a uniform when they are involved in the more hands-on aspect of their work. In the workplace, on or off-duty, operators and nurses are both easily identifiable to others.

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Forthcoming papers will discuss the workplace and study in more detail, in this short paper we necessarily skip over much. We do not wish to make any claim that the two types of workplace discussed here are the exactly same, merely to highlight that similarities exist, which may be a useful resource for design in either space. This is similar to Hughes et al.'s [6]'s suggestion of re-analysing ethnographic studies to "sensitise designers to the social organisation character" of different settings. While we suggest the relationship between workers at these two types of organisations may have similarities, clearly the relationship between a nurse and patient is radically different to that between an operator and an air separation unit.

2. WORKPLACES

2.1 Refinery

Our workplace study was carried out at *Kvasir*[1], the largest refinery of its type in Europe, situated on the west coast of Norway. The workplace is relatively unique within its parent company as it has a very flat management structure and encourages (and to some extent, requires) employees to be multi-skilled and work in a number of different capacities.

Employees at the plant are nominally within one of three 'networks', operations, maintenance or personnel. Employees are either shift workers, who work a varying shift pattern in six week cycles or 'daytime' workers, who always work regular office hours. Shift workers are organised into seven teams of eleven people. Each shift does one shift cycle with the regular daytime workers, with each shift member joining one of the organisational networks. The shift team is responsible for running and managing the plant for the period of their shift. Primarily, their role is to ensure that the plant is running safely and correctly, and that production is not interrupted. The team consists of operators from a number of different disciplines, a shift leader and two or more control room operators. Engineers and other daytime workers take a longer term perspective, such as considering, planning and scheduling upgrades.

Kvasir consists primarily of two areas: the plant and the administration building. The plant is where most of the danger and risk relating to health, safety and the environment (HSE) resides, thus the administration building is situated 2km away. HSE concerns outweigh any other at the plant, and there is strong emphasis to ensure HSE standards are met first before considering production or profit. The administration building is where people usually work, and also contains the central control room for the process, where two operators (CCROs) sit at control stations.

When work needs to be carried out on the plant, a 'work order' is produced in SAP, describing the tasks, lists related equipment, spare parts, safety analysis and other related information. Each task associated with an order usually requires a 'work permit', which is a temporary authorisation for work to be carried out. On the day of work, permits are printed out and signed by the shift leader at his office. The work team (or person) takes the document down to the work site and begins to prepare for work. Permits will often require an operator to perform particular preparation work for the work team, such as isolating electrical circuits, or closing valves. Once preparation is complete, the operator responsible for the area is called via radio. They then ensure the preparation has been carried out properly, signs the permit, and radios to the CCRO to 'activate' the permit. The CCRO performs the activation in SAP, and the work may commence.

2.2 Hospital

Hospitals are complex institutions consisting of both technical and clinical wards, central administration and laboratories [8]. Although nurses and doctors share a field of knowledge, they have diverse perspectives and tasks concerning the patient [16]. Nurses are more present at the wards, with doctors within reach, accessible through telephones or pagers. In order for good hospital care to take place a system that secures inter-professional collaboration and stability of information is necessary.

Nurses and doctors have quite distinct tasks; with nurses having the main responsibility of doing sentimental work which refers to tasks carried out on something alive, sentient and reacting [13]. Doctors' contact with patients is often limited to a short daily visit while nurses frequently interact with patients throughout the day, and often function as knowledge mediators between patient and doctor.

Through three daily shifts, nurses coordinate their work through a handover system for communication [5]. Handovers facilitate stability in the care, and consists of all information related to the patients. Face-to-face handovers require nurses from two shifts to be absent from the patients, and it involves repetition of documented information. In order to enhance efficiency, an increasing number of electronic patient records (EPR) projects are being implemented. The goal of the EPR is to expand its functionality and make it a complete information system where patient information is accessible, notifications can be distributed, and personnel can get assistance and communicate with others [3].

3. STUDY

Our study at Kvasir was carried out over a total of 13 days. Ten days of ethnomethodology-inspired fieldwork [12] were conducted by the first author. Here, observational study was the primary concern, with many hours spent with the shifts as they went about their everyday work in the offices, control room and out in the plant. Questions were frequently asked as they went about their work, and a series of more structured interviews were conducted with daytime workers. One week later the second author, who has a background in sociology, conducted 11 semi-structured interviews across a three day period with shift workers as well as some observational study. In total 37 interviews were conducted across a wide variety of roles and levels of experience (from apprentice all the way through to plant director). We were both introduced to employees by way of public displays situated in the administration building foyer and cafeteria, as well as personal introductions by "gatekeepers" [12].

4. DISCUSSION

4.1 Artifacts

Both workplaces use a mix of digital and non-digital artifacts, some of which are public, some of which are shared by a small number of people or some that are entirely private. Increasingly,

[1] Name anonymised

more artifacts are being digitised, but for both workplaces, non-digital artifacts still play an important role. In nursing there are whiteboards, work schedules, care records and so-on. In a study at a Norwegian hospital ward [8], the authors note a dependence of doctors and nurses on notebooks carried on their person, the author suggesting this is due to available computer technology in the ward not providing sufficient levels of mobility. At the refinery, logical process and instrumentation diagrams (P&IDs) are printed out and used by operators and engineers. Engineers find it useful to talk 'through' the diagrams, collaboratively annotating them during meetings to develop shared meaning. Operators used the diagrams more as a reference resource, for example they will tell an operator how to position valves for a particular work order, or where to find a particular instrument. Like [1]'s observation of hospital artifacts, P&IDs contain signs that are only meaningful to people with particular experience. An instrumentation operator might read a P&ID and see valve types, while a mechanic might read a P&ID and, based on coded identifiers, ascertain the pipe dimension and materials.

4.1.1 Single Input, Many Uses

Digital artifacts are more easily shared and transmitted, and as such, the readership and usage of information can increase. With increased exposure, there is a pressure to ensure high quality of the information. In a study of an electronic patient record (EPR) system which replaced much of the oral shift handover briefings, [9] reported that documentation quality improved because of its added importance. Since the next shift was not getting oral briefs, nurses knew they had to make their accounts as useful as possible, since that was now the primary conduit of information. At Kvasir, if an operator notices a fault out at the plant, she might enter it as a 'notification' on returning to the administration building. Notifications travel through the organisation, being reviewed, annotated and expanded. If the notification requires corrective work, it might spawn work orders and work permits. Notifications also serve as supporting documentation for why work needed to be carried out when reporting to investors. As one participant described it, there is "single input, many uses" for information, and thus this single input needs to be of a good quality for the many uses to be viable.

Personal Information Spaces (PISs) have been identified as a something nurses construct and maintain during their shift, and to some extent handover at the end [14]. PISs are assembled from a number of artifacts and sources, such as patient reports and charts. Likewise, operators regularly keep pocketbooks with process values, sketches and notes, along with printed documents. With the greater use of a common, digitised information space at the refinery, it seems however that operators' PISs are narrower. Most of the personal notes operators make during shifts have only transient value, serving merely as a link or reminder to make an entry into the common pool of information.

4.2 Collaboration

Like hospitals, the refinery workplace exhibits a rich combination of high and low intensity, distributed and collocated collaboration [1]. Difficulties with distributed collaboration are amplified by its intensity. Operators mostly use a shared radio channel for communicating within the shift and to on-site contractors. Normally, this system works quite well, however during an unexpected shutdown or a scheduled 'turnaround' (during which time the plant stops production and a large amount of maintenance and upgrading is carried out) operators report significant problems with the radios. The shared channel means there is a large amount of contention to speak, and it is harder for control room operators to triage incoming information, requests and notifications.

A boundary of time and space exists between shift and daytime workers, which is bridged through 'boundary objects,' primarily SAP-based documents and email. The shift team resides mostly within the control room area or out in the plant, while the daytime workers are in different wing of the building, in individual offices. Shifts working the evening or night shift do not have synchronous access to the rest of the organisation's expertise, with all requests and notifications having to be queued until the daytime workers start. Hospitals also change rhythm at night, gearing into a slower pace, with fewer nurses on shift. Most work is carried out during daytime, operations are done and medical checks completed, while at night, administrative wards, offices and laboratories close, putting off collaboration between the different expertises until daytime. Like doctors, engineers have a "fragmentary presence" [2] with the shift. While some will occasionally visit the control room during the week, visits to the physical plant are relatively seldom. Typically, operators are more familiar with the physical, practical side of the plant, and engineers are more familiar with the theory and logical side of the plant. This mismatch is often revealed when the two roles are discussing a proposed procedure. Here, P&IDs serve as a foundation for common understanding, bridging their respective domain expertise.

4.3 Redundancy

In a discussion of hospital ward-work, [2] note that not all redundancy is 'bad' redundancy, to be optimised away with new technology or work practice. As in hospitals, O&G workplaces use redundancy for effectiveness and safety. An example of this is the redundant work performed by the operators as they perform manual inspection rounds at the plant. Although much of the plant's important equipment is continuously tracked using one or more sensors, manual inspections and verifications at the equipment's location is an important task. Critical processes might additionally be monitored by heterogeneous sensors, for example using normal temperature sensors as well as laser-based or thermographic sensors. CCROs often treat alarms triggered from a single sensor with a low priority when they know that a true alarm state will have several sensors reporting similar values, assuming instead the sensor is faulty.

Redundancy is also evident in production of work orders, which usually begin life as notifications (see earlier discussion). This "single input" is reviewed multiple times by different people and groups across the organisation as it evolves towards an action being carried out, such as corrective maintenance work. While this may appear wasteful, each person involved applies their own core competencies and experience leading to a better quality, safer, more finely nuanced work order.

4.4 Planning

In the case Kvasir, planning of work is a particularly important task, one that is distributed across a number of people and competencies. Some work can only be done when the plant is not in operation, and thus scheduled to take place during a ‘turnaround’ which happens every two to three years, or in case of an unexpected shutdown. For the latter type of tasks, parts are ordered and stored close to the work site, so that work can commence immediately if the plant shuts down. Work is planned differently depending on its scale and impact; for much of the work, a work order is the primary artifact for a plan. Similarly to observations [10] made of nursing plans, work orders contain information from a number of systems, and are usually assembled or contributed to by a multidisciplinary set of people. Having a basis in an electronic system, work orders are extensively linked to disparate information silos, for example when viewing a work order, it is straightforward to pull up related schematics, data sheets, spare parts inventories and so on.

4.5 Power

The roles of both nurse and operator might traditionally be considered ‘below’ that of doctor and engineer, respectively. The lower power of nurses has been explained by way of their lesser importance to society’s well-being [17], the less demanding educational requirements [15] and gender imbalances [11]. In O&G, even at Kvasir where there is a small, flat organisational structure and informal workplace, power imbalances are present. Engineers set out a plan of intervention which the operators are then responsible in carrying out, in a similar way to doctors setting out a treatment plan to be implemented by nursing staff. Within the shift, the control room operators appear to have more power than regular operators, even though for most shifts this power is transitory as the position rotates among three or four people. CCROs issue and relay commands to “their” operators in the field, who are often oblivious as to why. The two CCROs, from their immense control stations, together largely control the entire plant, and are also responsible for safely shutting down the process in case of emergency. Our observations and interviews suggest however that power imbalances and associated issues at Kvasir are minimal compared with those often encountered in the medical establishment.

5. CONCLUSIONS

From a researcher or designer perspective, we believe there is some merit in identifying the essence of a work practice, and seeking it in other domains. In this paper we described the distinct analogues in the work-essence of doctors and nurses with engineers and operators.

While the work is clearly not identical, the designer can use pre-existing ethnographic accounts to expand and complement their own domain-specific fieldwork. For example, we would suggest that a designer looking at interfaces for patient and ward monitoring systems might do well to investigate how similar yet much more mature systems are used in the O&G domain. Accounts of the challenges and design responses for specialist doctors who serve several hospitals or provide tele-assistance will be increasingly salient for the O&G industry, as they seek to make a similar transformation with engineering work. Analogues can also be used as a provocative or playful resource for design, reappropriating concepts from one domain into another. For example in a brainstorming session we came up with the concept of using a stethoscope-like form factor for operators to use to ‘listen’ to sonified process values. Future work will expand the discussion and analysis of our Kvasir fieldstudy, as well as our design responses for this particular context.

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