

# SUPPORTING PROSPECTIVE SENSEMAKING IN AN UNPREDICTABLE WORLD

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## Abstract

We studied the role of sensemaking processes in the safe and efficient performance of surgical procedures. The study is based on observations, semi-structured interviews and informal conversations with surgeons, anaesthetists, operating nurses and anaesthetic nurses. The members of the operating team paid great attention to what might happen during the next seconds, minutes and hours. They thus built a capacity for anticipation which enabled them to collaborate smoothly and prepared them to handle undesired but foreseeable occurrences. We label this activity "prospective sensemaking" and argue that it is a precondition for safe and successful completion of surgical procedures. Instead of waiting for things to happen and making sense of them in retrospect the operating team members constructed plausible projections of what might happen and how they might handle such plausible futures. We discuss how procedures and technology may support prospective sensemaking. In this way, the paper points to resilience strategies that are compatible with the values and capacities of operating teams and that make good use of their current resources and capacities.

## 1 INTRODUCTION

This paper is based on a study of the role of sensemaking processes in the safe and efficient performance of surgical procedures. Working in a surgical team within an operating theatre involves relying on a variety of roles, procedures and technology. The varying entities within an operating theatre, not least the patient, are complex and interlaced, which means that different types of surgery include elements of unpredictability of varying degrees (Rosness et al., in review). We found that the members of the operating team paid great attention to what might happen during the next seconds, minutes and hours. They thus built a capacity for anticipation which enabled them to collaborate smoothly and prepared them to handle undesired but foreseeable occurrences related to patient status. We label this activity "prospective sensemaking". Instead of waiting for things to happen and making sense of them in retrospect, the operating teams constructed plausible projections of what might happen and how they might handle such plausible futures.

Although our approach to sensemaking is highly influenced by Weick (1995), we investigate aspects of sensemaking that are distinguished from those Weick emphasised in two regards: First, while we do acknowledge that sensemaking is a social process, we also include procedures and technology in our analysis. Secondly, our study of sensemaking also covers situations that Weick characterises as non-events. These are situations where operations progress in a smooth and safe manner. We claim, however, that the operations pass smoothly and safely not because little happens, but because much happens. Our study was rigged to capture the *dynamic events* – supported by social and technological resources – that are suggested to be central ingredients of prospective sensemaking. Our approach to sensemaking and the distinctions we make between retrospective sensemaking and prospective sensemaking can thus be related to the distinction between Safety I and Safety II (Hollnagel, 2014); rather than being occupied primarily with those situations where things obviously break down and must be explicitly handled, we devote attention to what happens when apparently nothing happens, when operations proceed smoothly and the outcome does not evoke anyone's attention.

Traditionally, when one has managed patient safety the idea has been to adopt safety solutions from other

industries relying on perspectives such as quality management, lean production, and high reliability organizing). However, in order to improve the quality of health care and patient safety in particular, health care needs to focus on its ability to deal with the unpredictable through various ways of adapting (Hollnagel et al., 2013). Our aim was to study teamwork practices during naturally occurring surgical procedures in line with one of the main premises of Safety-II (Hollnagel, 2014), to understand how a system is able to succeed under varying conditions by focusing on the nature of everyday clinical work as it is done (Hollnagel et al., 2013). This paper also contributes empirically to knowledge on one of resilience engineering's four cornerstones, namely anticipation (Hollnagel et al., 2011) and how one at the sharp-end actually is able to know what to expect as the surgical intervention proceeds. This paper describes the characteristics of prospective sensemaking (Rosness et al., in review) in the operating theatre and discusses how technology and procedures can further support (and strengthen) this phenomenon. The paper also discusses implications for training the various roles in the operating theatre.

The study is based on observations, semi-structured interviews and informal conversations with surgeons, anaesthetists, operating nurses and anaesthetic nurses.

## **2 THE NOTION OF "PROSPECTIVE SENSEMAKING"**

The notion of "prospective sensemaking" may be viewed as an elaboration of aspects of sensemaking that received limited attention in Weick's (1995) conceptualisation of sensemaking in organisations. According to Weick, the term "sensemaking" means what it says, i.e. the process of making sense. He conceptualised sensemaking as a social process rather than an individual, cognitive process. According to Weick sensemaking is typically triggered by uncertainty or ambiguity. He further suggested that sensemaking is a retrospective process in the sense that actors look back on what has happened to make sense of the current situation (Weick, 1995, p. 24-30). It is also retrospective in the sense that actors look back on their previous words and actions to make sense of them.

We define "prospective sensemaking" as sensemaking processes where the attention and concern of people is primarily directed at events that may occur in the future. The qualification "primarily" is necessary because, even when our main focus is on possible future events, we may draw on past experience to make sense of the future, and thus attend to the past as well.

Based on our observation and on interviews and informal conversations with members of the operating teams we propose the following characteristics of prospective sensemaking (Rosness et al., in review):

1. The persons involved are primarily concerned with their own and the team's successful handling of events in the near or intermediate future, ranging from seconds and minutes to weeks and months into the future. Their attention is thus directed at the future, rather than the past.
2. Prospective sensemaking does not necessarily require strong external cues or triggering events to occur. While retrospective sensemaking activities are typically triggered or intensified by uncertainty or ambiguity, prospective sensemaking also occurs spontaneously, as a "natural" part of the work practice.
3. Prospective sensemaking relies on both verbal and non-verbal communication, including observation of the actions of others and of the effects of those actions.
4. Prospective sensemaking can be open to the possibility of alternative chains of events – the future may be conceived as an event tree rather than a single path of events. An implication of this is that prospective sensemaking allows for ambiguity and uncertainty.
5. The main outcomes of successful prospective sensemaking are practical preparations to handle possible future events, mental preparedness to interpret future events and improved coordination in tasks involving intertwined actions of two or more persons.
6. The process of prospective sensemaking may involve human as well as non-human actors, including different forms of representations or models.

A straightforward argument for the importance of prospective sensemaking for the safe and efficient performance of surgical procedures can be made by considering how the performance of a surgical procedure would proceed if the operating team did *not* engage in prospective sensemaking. The time to complete surgery would increase because the scrub nurse would not have the correct tool ready at hand; the surgeon would repeatedly have to wait for the ambulating nurse fetching tools and materials; the patient would be at risk of experiencing pain while under general anaesthesia because the anaesthetic nurse would be unable to adjust the distribution of painkiller prior to strong pain stimuli, etc. Prospective sensemaking can also be crucial for

the maintenance of organisational structure, since confidence in leaders tends to be destroyed if organisation members are not able to make sense of their leaders' actions (Weick, 1993). Participants in the study confirmed that they had experienced significant variations in the effectiveness of prospective sensemaking in operating teams, and that ineffective prospective sensemaking did lead to inefficient performance and a general sense of unease in the operating team. They said that this state was most likely to occur when members of the operating team were unfamiliar with the surgical procedure or when the surgeon failed to communicate clearly about the expected course of the operation.

### **3 PROCEDURES**

We observed several ways in which procedures supported prospective sensemaking in conjunction with the surgical interventions.

The Safe Surgery Checklist ("Trygg kirurgi"; Høyland et al. 2013) checklist prescribes items to be checked and information to be shared at three different milestones during a surgical intervention. This is a generic checklist, common to a diversity of surgical interventions. This checklist provided an opportunity to recover from errors such as omissions, misunderstandings and incorrect information. Moreover, by providing a timeout, the checklist encouraged exchange of information, concerns and requests even beyond the items specifically mentioned in the checklist. In a feedback meeting, after we had presented the notion of "prospective sensemaking", a surgeon commented that the Safe Surgery Checklist supported prospective sensemaking because it promoted sharing of information that the other members of the operating team needed to foresee what might happen during the surgical intervention.

Several operating nurses mentioned that they had procedures covering the specifics of each surgical procedure, for instance what tools, materials and equipment should be prepared. These procedures helped prospective sensemaking by outlining the expected course of the surgical intervention as well as some possible contingencies, and by prescribing the tools and equipment to be prepared for each intervention. However, some operating nurses mentioned that surgeons in some cases preferred to use tools or equipment that deviated from the standard procedure, and that they might call the surgeon the day before the surgery to check for such preferences.

A surgeon told us about how he prepared for an operation. He insisted that a surgical intervention is by definition planned in advance. The master plan can, however, be made up of several sub-procedures. He usually has a "plan B" and perhaps a "plan C" ready at hand because he may not know which plan will be optimal before the intervention starts. Because the surgeon made up a "plan B" and perhaps a "plan C" in advance, preparations could be made for different courses of the surgical procedure. The nurses would prepare instruments and equipment for carrying out "plan B and C" as well as "plan A". This would allow the operating crew to change smoothly from "plan A" to "plan B" if need be. A prerequisite for this smoothness was that the procedures used by the operating nurses corresponded in scope to the procedures referred to by the surgeon. The procedures served as black boxes, which allowed for effective communication about combinations of several alternative and intrinsically complex courses of the surgical intervention.

To summarise, procedures may support prospective sensemaking (1) by creating a timeout and cues for exchange of information, concerns and requests, (2) by outlining the expected course of the intervention and prescribing the preparations, and (3) by providing building blocks for devising a robust master plan for the surgical intervention.

### **4 TECHNOLOGY**

A series of representational tools entered into the work of making sense of current and future states of the object of investigation; visualisations based on microscope, X-ray, Computer Tomography, Magnetic Resonance and ultrasound were all used actively to evaluate and negotiate current and future states and thus to expand and articulate the border between the known and the unknown. This, we argue, serves as useful input to inform the team about where the limit goes between necessary adaptation and risky deviation.

One example of this was an operation of a benign tumour on the pituitary gland. A central challenge in this operation was to draw the line between what tissue to remove and what to leave behind, thus determining when to stop operating. Often, this will correspond to the border between healthy and sick tissue. In this case, however, pragmatic concerns made the border between what tissue would exert pressure on the visual nerve and what would not as the relevant border. Should too little be removed, the tumour would still exert pressure on the visual nerve. Should too much be removed, then neurological side effects might occur.

Being inaccessible to the naked eye, the tumour had to be enacted through a series of representations

produced by a series of tools (microscope, X-ray, MR, ultrasound). Through these tools and the practices accompanying them, the ontological status of the tumour as an object was gradually strengthened. As explained towards the end of this section, the ontological status makes a difference since it is central in producing the ad-hoc border that eventually will count as a pragmatic stop criterion to the surgeon. While MR images are taken *before* the operations and thus serve as a point of reference, X-ray images are taken *occasionally during* the operation for the purpose of navigating. Ultrasound images are created and discussed in *real time*, in an attempt to distinguish the tissue to be removed from the tissue to be left untouched while the surgeon is working, with the direct impact this will have for the result of the operation and the patient's vision in the future.

Consider the following extracts from different stages in the operation:

1. *The ultrasound technician refers to the screen where the microscope image is projected: "What is that white thing?" Surgeon: "I don't know"*

2. *After a while, the doctor says loudly to everybody in the room (who can see on two different screens what he sees in the microscope): "I wonder if that is the pituitary gland we see there...". He walks over to the screen in the corner again, where he discusses with the technician: "Should we try and see if we can see anything on the ultrasound?" He starts walking back to the operation table, when he is called back by the technician, who points to the screen: "Be aware of those blood vessels... come here and see."*

3. *The ultrasound technician and the surgeon discuss the ultrasound images and try to sort out what is tumour and what is healthy tissue, and implicitly when to stop operating. More images are taken. More discussion. They can see the tumour, but they note that there is not much manoeuvring space to access it. They walk together back to the MR image displayed on the PC in the corner. The discussion at this point integrates three highly mediated representations that, together with the microscope images, amount to the final representational state that is worked upon.*

During the next few minutes, the doctor demonstrates the craftsmanship of surgery, partially removing the tumour with basic tools (forceps and scalpels), followed by the production of some final ultrasound images. As the surgeon told us after the operation, the border between sick and healthy tissue is not easy to establish clearly, and sometimes it is not what defines the stopping criteria either. Thus, in absence of a de facto border, the border should be thought of as a pragmatic border, constructed by aid of representational technology in combination with considerations about future implications for the patient's vision.

The significance of *shared representations* for prospective sensemaking was exemplified by the operating microscope. The microscope supported prospective sensemaking by providing a dynamic real-time representation, which was shared by and made intelligible to the whole operating team. The scrub nurse, the ambulant nurse and the anaesthetic nurse used this shared representation to update their conception of what was happening and what could happen in the near future.

Image-producing technologies may also have unintended effects. The heavy instrumentation in the operating theatre produces a lot of noise. This made our observation more difficult, since it was sometimes hard to hear what people said to each other. The noise may also disturb the team's communication. Another possible effect of the technologies is that they may generate additional workload and draw attention away from phenomena that may be more important at certain moments. These are general considerations that we have not focused on in this study, but that would certainly be worthwhile to explore in other studies.

## **5 DISCUSSION: HOW TO SUPPORT PROSPECTIVE SENSEMAKING**

Although we characterise prospective sensemaking as anticipation, we do not suggest that prospective sensemaking is about anticipating the future as it will actually unfold. Rather than expecting the unexpected, or imagining the unimaginable, prospective sensemaking actualises *possible* futures that may or may not occur. Thus, it works as an elaboration of potential future states that one may prepare for. By elaborating on potential future states prospective sensemaking helps articulate the domain of the expected and by that drawing visible borders towards the unexpected. One central challenge of resilience is that the necessity to sometimes operate outside the prescribed work practices is problematic since one often does not know how far from the prescriptions it is justifiable to go. One way of talking about this is to say that one does not know when the border for safe operations (as portrayed by Rasmussen, 1997) is crossed, since this border usually is made visible only in retrospect. The border between the domain of the known and the terra incognita, however, may be operationalised through prospective sensemaking. A central ingredient of prospective sensemaking is to articulate this border by actualising potential futures.

Our notion of "prospective sensemaking" may to some extent coincide with the notion of "anticipatory thinking" proposed by Klein et al. (2010). Klein et al. characterise anticipatory thinking as a "future-oriented aspect of sensemaking". The difference between the two concepts appears to be more in style of conceptualisation than in the phenomena they seek to capture. Klein et al. conceptualise "anticipatory thinking" in terms of postulated cognitive functions that apply to both the individual level and the group level. We developed the notion of "prospective sensemaking" in an abductive manner from a study of everyday practices in the operating theatre, using techniques associated with grounded theory. "Prospective sensemaking" emerged from this analysis as a promising core category, with a capacity to integrate a broad range of findings from the interviews and observations. Following Weick, we think of sensemaking as an intrinsically social process. We prefer the term "sensemaking" because it hints at the interplay with retrospective sensemaking (Weick, 1995), and because in everyday language "thinking" is usually associated with covert cognitive process at the individual level. Another contrast with the style of theorising of Klein et al. is that we prefer to suspend normative judgements on whether prospective sensemaking is "correct" or "false". When discussing barriers to anticipatory thinking, Klein et al. seem to contrast fallible thinking in the real world with a normative ideal of rational logical thinking.

We found that procedures may support prospective sensemaking in several ways:

1. As illustrated by the Safe Surgery Checklist, a procedure may help to create a timeout for checking that necessary preparations had been carried out and for exchange of information, concerns and requests and provide a structure for this information exchange.
2. Procedures specific to each surgical intervention and to the role of the operating nurses outlined the course of the intervention and prescribed the preparations to be made.
3. Procedures may be used as building blocks for devising a robust master plan for the surgical intervention. Such master plans may include two or more alternative trajectories, one of which may subsequently be selected based on findings during the intervention. This master plan provided an effective means to communicate the surgeon's expectations and the need for materials and equipment to the operating nurses.

Our results suggest that the utility of the procedures may be enhanced when they are used in a flexible manner that is compatible to the constraints of the task (Grote 2008). The utility of the Safe Surgery checklist was enhanced by team members providing information or raising concerns beyond those specifically mentioned in the checklist. The operating nurses introduced some flexibility into the procedural control of surgical interventions by checking if the surgeons had specific preferences and by combining two or more procedures in cases when the surgeon needed the flexibility to change plans during the intervention.

Prospective sensemaking is also supported by representational technologies; both microscopes and 3D ultrasound apparatuses are examples of technologies that provide dynamic real-time representations that are not only available to the surgeon, but to the whole team. These representations are used to make sense of current and future states, both collectively as shared understanding, and less convergent as boundary objects (Star and Griesemer, 1989) offering different (not in the sense contradictory) meanings to different actors.

Can training contribute to effective prospective sensemaking? Operating nurses participating in our study told us that there were considerable differences between how surgeons communicated about the progress of the intervention, whereas a surgeon told us that practices to enhance prospective sensemaking were not part of their training. Rather than training "non-technical skills" as a separate add-on, it might be worthwhile to seek ways to train practices supporting prospective sensemaking as an integrated part of the basic training of health professionals. This might include training prospective operating nurses and anaesthetic nurses skills related to sharing information, raising concerns, and "reading the situation" based on non-verbal cues.

Advances in information technology and visualisation the later years have had a profound effect on how one thinks about and seeks to arrange for collaboration in complex, information dense and risk-prone operations. Integrated Operations (IO) in the petroleum industry may serve as one example; IO is an operating philosophy where greater use of real-time data and stronger integration across geographical locations and professional disciplines is expected to enable faster, better and safer operations (Albrechtsen and Besnard, 2013). The point here is not to focus on the efficiency measures, but on the technology that supports sensemaking and collaboration. Central resources in that operating regime are representations and visualisations that are shared by geographically distributed teams. These representations and visualisations may refer to current states of affairs, or they may be constructed models that refer to potential future states or safe limits for those. We have witnessed several initiatives of research and development collaboration between the health domain and the petroleum domain in order to share knowledge on these issues. Without going into detail on

how representation and visualisation tools may support not only desired processes, but also support undesired processes, or anti-tasks (Turner, 1978), we may establish that they are acquiring an increasingly central role in the operation theatre.

## 6 CONCLUSION

In order to manage resilience we need to understand the strategies, techniques and resources people use to anticipate and handle unlikely but foreseeable consequences. We have labelled observable aspects of this process "prospective sensemaking". Technological means (including procedures) may support prospective sensemaking in several ways: (1) by prescribing, legitimising and structuring sensemaking activities; (2) by directing the work through engineered work processes, making projections of what is to happen in the future easier; (3) by providing building blocks for devising and sharing master plans with alternative trajectories; (4) by providing shared and continuously updated information, thus facilitating coordination; (5) by establishing boundaries between the known and the unknown; (6) by providing continuously updated information combined with projections of expected and/or desired future states, indicating deviations from expected or desired trajectories at a sufficient early point in time to make necessary corrections.

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