

# The Ambiguous Status of a Tool: The Case of the Anaesthesia Chart

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## ABSTRACT

The aim of the research presented in this paper was to study the subtleties of the anaesthesiologist's practice in order to design a digital replacement for the anaesthesia chart. To analyse the anaesthesiologist's work, we used a mixture of ergonomic work analysis and ethnomethodological approach. We conducted over 100hrs of field observation in the Operating Theatre of two Greek hospitals. The analysis of this data shows that the chart has an ambiguous status because of the conflicting interests shaping its use (eg. cognitive tool, juridical evidence). These findings demand a new approach for the design of the digital chart.

## Keywords

Anaesthesiology, anaesthesia chart, ethnomethodology

## INTRODUCTION

The act of giving of anaesthesia is a complex, event driven task with tight constraints and adverse consequences. The goal of the anaesthesiologist isn't to simply put the patient to sleep. The anaesthesiologist is also responsible of ensuring the patient's well being and optimal surgical conditions (adequate muscle relaxation etc.).

There has been extensive research on the field focusing on various aspects of the anaesthesiologist's practice: classical ergonomics approaches (Held et al., 1996), studies on human error (Marmaras et al., 1994, 1996), cognitive engineering (Cook et al., 1991, De Keyser et al., 1994) etc.

There also have been efforts to develop software to support the anaesthesiologist during the operation. Such software either follows an Expert System (Mora et al, 1993) or an Ecological Interface approach through integrating the monitor's displays. Expert Systems belong to the GOFAI (Good Old Fashioned Artificial Intelligence) tradition of replacing rather than supporting the practitioner. But such systems don't take enough of the context into account, so their suggestions tend to be irrelevant for the situation at hand (Dreyfus, 1972). Another approach are integrated or "ecological" displays (Zhang et al., 2002) which aim at integrating data into rich, complex units that could lead to improved performance of the actor. This approach has shown promise but nevertheless focuses on a limited part of the anaesthesiologist's practice.

The present study deals with the anaesthesia chart which is a paper form constituted by a grid, where during the operation the anaesthesiologist records the timeline of the patient's physiological parameters during the operation (blood pressure, pulse etc), and data fields where he can record the drugs administered as well as information about the patient (age, weight, ASA rating) which was gathered during the preoperative assessment.

The goal of our research was to study the subtleties of the anaesthesiologist's practice in order to design a replacement for the anaesthesia chart. Simultaneously, we wanted to exploit the opportunities offered by the digitization of the chart so that it would be able to support the anaesthesiologist's tasks while removing the burden of manually recording the progression of the patient's vital signs.

What triggered the research was the initial assumption that the anaesthesia chart was an artefact which represented the crystallization of years of practice and was used by the practitioner as a cognitive tool in the sense of Activity Theory (Nardi, 1996). In fact in a preliminary interview an anaesthesiologist claimed that he couldn't picture his work without it. There is also a growing tendency to introduce information technology into all areas of the Operating Theatre and integrate them through a hospital-wide information system, which demands the digitisation of the patient record and the anaesthesia chart.

## THE METHOD

To analyse the anaesthesiologist's work, we used a mixture of ergonomic work analysis (De Keyser, 1991, Wisner, 1995) and ethnomethodological approach. More specifically, we focused on the anaesthesiologists' interactions with their environment, their mediated treatment of the patient and especially their use of artefacts like the anaesthesia chart.

Our research was conducted between November 2002-May 2003 and involved two public Greek hospitals and 20 anaesthesiologists. The two hospitals specialized in different areas: one was an oncology hospital and the other a children's hospital. Of the 20 anaesthesiologists, 13 were senior and 7 residents. Nine of the senior anaesthesiologists had 15 or more years of experience. All the residents were past their 3 (of a total of 5) year

of residency. All of the nurses involved were fairly experienced (over 10 years) except one who was on her first year in the anaesthesiology department.

We conducted over 100hrs of field observation in the Operating Theatre (OT). The duration of the operations assisted ranged from 30min (tonsillectomy) to more than 6 hours (colectomy).

The number of people in the theatre depended on the type of operation and ranged from five (a surgeon, a nurse, an anaesthesiologist and an anaesthesiology nurse) to more than ten. The anaesthesia team in the first hospital usually consisted of a senior anaesthesiologist, a resident and an anaesthesia nurse, while in the second it consisted of a senior anaesthesiologist and an anaesthesia nurse (there were no residents).

The main part of the study was comprised by the field observations in the OT which were complimented with self-confrontation interviews. The researchers had negotiated their entry into the OT with the anaesthesiology department and the head nurse; the rest of the staff learned of our presence the moment they entered the OT. Sometimes we explained the aim of our research, but on some occasions the anaesthesiologist found it more appropriate to introduce the researcher as a doctor doing research for his PhD as she thought that “this man would never accept non-medical staff to be present during his work!”.

We had to rely on written notes taken during the operation and photocopies of the completed anaesthesia chart. We also performed self-confrontation interviews with the anaesthesiologists whenever possible (usually

shortly after the operation in the doctors’ lounge. These interviews differed from typical self-confrontation on that the actor didn’t confront his actions on video, but on the reconstruction made by the written notes and the completed anaesthesia chart.

The anaesthesiologists objected to the idea of a video camera as they thought it was too obtrusive and feared it would cause reactions by the surgeons and nurses.

In addition we tried to exploit every incident to better capture important elements of the task. For example, in an incident the senior anaesthesiologist didn’t have her glasses with her so she had to lean very close to each monitor she wanted to read from: this didn’t give us ecological validity in the sense that the fact that this surely influenced the number of times she read from the monitors. The data gathered during this incident do not represent the normal course of action, but on the other hand one could argue that the added effort required by the anaesthesiologist to read from the monitors because of this deprivation, lead us to a better indicator of when he actually needed information from the monitor.

The collected data were processed and in the following days there was a follow-up discussion on some of the incidents involved. These interviews were done either with each member of the team individually and a few times all the members of the team were present. The notes were transcribed into a spreadsheet and categorized according to actor, type of action, artefact involved and procedure (see Table I for an example). Through the analysis we discovered regularities in the team’s behaviour in the domain.

**Table I:** An example of the transcribed collected data

Actant	Transcriptions	Type of action	Time	Monitor readings	
				Heart rate	Pressure
Surgeon	The Hickman introducer is broken, they search for another	Action	13:19	116	110/68
Anaesth#1	Brings another introducer that is similar	Action			
Surgeon	Tries the new introducer	Action	13:21		
Anaesth#1	The intravenous fluid is finished!	Utterance	13:24	121	108/67
Anaesth#2	(anxious) Has the vein been destroyed?	Utterance			
Anaesth#2	If the vein is out, I’m going to commit suicide!	Utterance			
Anaesth#1	She’s got many (veins) on the leg	Utterance	13:26	130	103/62
Anaesth#1	Quickly!	Utterance			
Anaesth#1	Searches for a vein in the leg	Action			
Anaesth#2	Shows signs of tachycardia	Action			
Anaesth#1	OK I found it!	Utterance	13:28	140	106/63
Anaesth#2	She had 150 with the vein out	Utterance			
Anaesth#2	Administer esmeron 50!	Utterance			
Anaesth#1	Shall I administer some Fendanyle?	Utterance			

## FINDINGS

Although our initial framing of the problem had the chart as the focal point (Marmaras et al, 2004), during the initial interviews and field observations we discovered that the chart was rarely used as a tool supporting the anaesthesiologists' memory (Table II). We observed that only residents and nurses complete the chart meticulously, while the senior anaesthesiologists do so at irregular intervals or even after the operation.

**Table II:** Mean time between consecutive gazes at the anaesthesia chart

Anaesthesia Nurses	8min
Residents	6min
Senior Anaesthesiologists	20min

Additionally, there is a reluctance to record the true progression of the patient's physiological parameters over time, and most of the minor changes that took place during the operation (arrhythmias, low O<sub>2</sub> saturation level etc.) were never recorded.

To explain this phenomenon we formulate the following hypotheses.

First, there is a predominance of the chart's legal status over its intended use; in fact it can and has been used as evidence in a charge of malpractice. For example in the case of *Vulecich v Bolgla* (85 Ill. App. 3d, 810, 407 N.E. 2d 566, Illinois, 1980) where the patient's theory of the case was based on the claim that the anaesthesiologist did not monitor the patient's breathing and he used the fact that he failed to chart the patient's respiration. In another case (*Kearl v Board of Medical Quality Assurance* (189 Cal. App. 3d, 1040, 236 Cal. Rptr. 526, 1986)) there was a question whether the anaesthesiologist monitored constantly the patient's vital signs. The anaesthesiologist claimed that he monitored them every 5min but recorded them at 15-minute intervals because the chart provided space for recordation only at 15-minute intervals. The difference is extremely important because it takes only 3 to 4 minutes for irreversible brain damage to occur. So, the chart must appear to be completed and as "nominal" as possible; it is in view of this goal that some anaesthesiologists omit incidents or complete the chart postoperatively.

Second, updating the anaesthesia chart constitutes an additional object of attention, which does not seem to offer any tangible benefits, especially during short, routine operations. In fact, the anaesthesiologist has to divide his attention between the mediated (monitors) and direct view of the patient and the surgeons' actions. The mutual awareness (Hutchins, 1995) between anaesthesiologists and surgeons is important as the anaesthesiologist's handling of the procedure is contingent on the surgeon: the surgeon sets the pace and as the operating theatre is a system with virtually no

slack, this is a potential source of conflict. Depending on the perception the anaesthesiologist has on the surgeon he may monitor the operation more closely for blood loss ("you cannot trust X. He's a butcher!"). The anaesthesiologist acts proactively in regards to the type of treatment: e.g. some treatments are known to cause bradycardia (application of adrenaline), so the anaesthesiologist has already prepared an atropine shot to administer as soon as he observes a drop in cardiac pulse. On other occasions we noticed a negotiation between the anaesthesiology team and the surgeons regarding the pace of the procedure.

Although we found ample evidence of non-systematic use of the anaesthesia chart, it was a difficult subject to handle that couldn't be tackled in a typical interview; only after many days spent in the employees lounge sharing coffee with the team's members were we able to have a resident admit that "*some anaesthesiologists do this because there is nothing to gain from it and it could lead to trouble*". So the anaesthesia chart is in the uncomfortable position that it is most needed by the anaesthesiologist when it is most feared: during a crisis.

## DISCUSSION

While the anaesthesia chart in most times is neglected in actual practice, it could assist the anaesthesiology team by supporting the anaesthesiologist's memory and providing a solid representation of a timeline of the patient's physiology and the drugs administered.

For example, during an operation we observed that the anaesthesiologist didn't remember when he last administered a muscle relaxant, and couldn't consult his chart because he only filled it post-operatively. This resulted in a potentially dangerous double dosage.

The representation of the patient's physiology is also important considering the anaesthesiology team's division of labour; in fact, rarely is an anaesthesiologist present during the whole operation. Anaesthesiologists often take breaks and either spent some time in the doctor's lounge or more often visit other theatres to talk with their colleagues about their cases; these rounds are just for relaxation but contribute to the cohesion of the team. When a member of the team leaves for a break another member takes over (in the first hospital which had many residents there always was an anaesthesiologist present; in the second when the anaesthesiologist took a break the anaesthesia nurse took over).

If we consider the Joint Cognitive System (Woods, 1990) as the anaesthesia team and the artefacts it uses (monitors, anaesthesia machine, and chart), we see that the chart is the only part that is present during the whole procedure and can carry an adequate representation of the progress of the anaesthesia act. We observed that the team tries to compensate their partial use of the chart by reporting their actions to the member of the team that re-enters the theatre after a break. But this communication is asymmetrical: we noticed that a

member lower in the hierarchy of the team (resident, nurse) always reported to the senior anaesthesiologist, while the senior anaesthesiologists rarely reported their actions and only gave instructions for future ones.

The anaesthesia chart seems trapped in a sideline role during the present conditions and consequently an effort to redesign it could be considered of no value. However, if we take a holistic perspective and view it as a node in a network that is now undergoing radical change, its role and form should be re-examined. The change comes from the push to rationalize the management of the hospital, which comes hand in hand with the adoption of a hospital-wide information system. There is also a push from other stakeholders (insurance companies, government agencies etc) to have detailed and reliable data on every operation along with the treatment provided (Berg et al, 1997). This process sees the emergence of an actant-network (Latour, 1987) where the practitioner is just another node. As a result the implementation of the anaesthesia chart in IT seems inevitable and the only course of action is to try to shape it so that in the degree possible it will not disturb current practice, while at the same time harness the opportunities given by the new technology.

#### EPILOGUE

The case of the anaesthesia chart present an interesting problem for cognitive engineering: if one takes a narrow view trying to support the cognitive aspects of the task, he runs the risk of designing an artefact that will be incompatible with other aspects of the task and therefore will not be used. On the other hand if we holistically consider the anaesthesiologist's practice as well as the interests of the other stakeholders, we come to an impasse because of the conflicting interests which translate into conflicting requirements. A way to overcome this impasse would be to design the artefact in a layered manner so that it will be open for catachresis (Papantoniou et al, 2003). For example the anaesthesiologist will be able to modify the chart postoperatively (although this is undesirable from the management's point of view). Of course such a resolution would require an introductory period of the digitized chart. The emergence of breakdowns during this period will trigger the necessary negotiations between the stakeholders towards a new equilibrium.

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