Workflow Integration Matrix: a framework to support the development of surgical information systems

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Design and technological development of surgical information systems for complex workspaces, such as the surgical theatre raise a variety of challenges for the designer. These challenges originate from the role of the designer within a multidisciplinary development team involving surgeons, technologists and designers. This role creates two needs: first, the analysis of surgical requirements and processes within the surgical workspace, and second, the sharing of the requirements and processes within a multidisciplinary development team. To address both the needs, this paper proposes a framework called the Workflow Integration Matrix (WIM). WIM uses theories of human behaviour in problem solving, especially the information processing paradigm. The proposed framework intends to provide evidence-based decision-making for the development of new surgical technologies.

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Human-centred development of information systems for complex workspaces such as, the surgical theatres is a critical link to improve healthcare and patient safety (Taylor et al., 1996; Stead et al., 2000; Patel et al., 2001; Stone and McCloy, 2004; Buckle et al., 2006). Here, the complexity of the surgical workspace is characterised by time critical decision-making tasks (Elstein et al., 1978; Gordan et al., 1993), unpredictability of events (Hunink, 2005), low tolerance for errors (Reason, 2000) and importance of timely communication between members of the surgical team (Lingard et al., 2004). In this paper, we focus on supporting the development of surgical information systems, which provide real-time imaging and procedural support to the surgeon, to enhance surgical decision-making. The development of these systems is dependent on the knowledge of the surgical processes and requirements (Buckle et al., 2006; Sanderson, 2006) and its structured communication between the members of a multidisciplinary development team (Cross, 1989; Milne, 2000; Vink et al., 2006). While developing

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the surgical information system, if the surgical processes and requirements are analysed insufficiently or communicated inaccurately within a multidisciplinary development team, gaps will appear in the comprehension of the scope and the function of the system. This may lead to medical errors affecting patient's safety (Bogner, 1994).

The multidisciplinary development team for the surgical information systems usually consists of surgeons, technology engineers and designers. Here the designer in the team is confronted with two main challenges:

1. Analysis of the requirements and processes based on surgical problem solving within the surgical workflow.
2. Facilitate communication of requirements, processes and possibilities between surgeons, technology engineers and designers of a multidisciplinary team?

The first challenge necessitates analysis of the surgical workflow in order to identify the information processes and requirements within the surgical workspace. Similar to other complex workspaces, the technological development in a surgical workspace is critically dependent on the knowledge of problem-solving processes and the requirements related to it (Simon, 1969; Hollnagel and Woods, 1983; Rasmussen, 1986; Woods, 1986; Vicente, 1999). Based on the theories of problem solving in complex workspaces (Simon, 1969; Dörner, 1996; Badke-Schaub and Buerschaper, 2001), the term surgical workflow is defined as the surgical problem-solving process that is determined by the boundaries in terms of possibilities and limitations within the surgical workspace in the three surgical phases: before surgery (preoperative), during surgery (intra-operative) and after surgery (post-operative).

Current surgical workflow analysis frameworks on modelling of surgical procedures for multi-modal image guided surgery (Jannin et al., 2003), XML based intra-operative surgical workflow framework (Neumuth et al., 2005) focus primarily on identification of the technological requirements and processes and do not fully consider analysing the surgical requirements. This leads to solutions that are influenced by the latest technological trends (Bainbridge, 1983) and are imposed rather than required by the surgeons (Patel et al., 2001). As stated by one of the surgeons *'…This is impressive technology, but I don't see where exactly it supports my tasks…even if it is given for free I wouldn't install it in my hospital'*. In order to avoid the technological push in the surgical workspace raises the need to develop a surgical workflow analysis framework, which is based on the knowledge of the surgical problem-solving process (Jalote-Parmar et al., 2007a).