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Towards a framework to select techniques for error prediction: Supporting novice users in the healthcare sector

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ABSTRACT

Whilst healthcare has increased its awareness of the retrospective safety assessment techniques, such as root cause analysis, adoption of the corresponding predictive safety assessment techniques has been slow and sporadic. Reasons for this may include lack of support in technique choice and practical knowledge in the published literature. Whilst there have been many publications on these techniques, few have aimed to support the novice user in selecting a technique from the broad array of choice to facilitate targeting of education in techniques for specific purposes.

This paper aims to address this through collecting an evidence base towards developing a bottom-up (resources and constraints) and top-down (requirements) approach to technique selection.

Conclusions indicate there is a lack of practical experiences described in the literature to conclusively define a technique for selection and a need for a dedicated research in this area to make it accessible for healthcare and other novice users.

1. Introduction

Incident investigation techniques have been increasingly used in healthcare and are supported by literature specifically written to help novices in choosing techniques (Johnson, 2003). However, a similar pattern has not occurred for predictive safety techniques. Despite many decades of acceptance of the predictive safety techniques in other industries, Lyons et al. (2004a) found only seven techniques had been published as being used for healthcare application (change analysis, FMEA, HAZOP, influence diagrams, SHERPA, event trees and fault trees). This was particularly noteworthy when task analysis – the precursory step for many human reliability analysis techniques – has been applied to several areas within healthcare.

The reasons for its narrow application may be the lack of awareness that there are so many usable techniques or due to the challenge of choosing between the overwhelming number of techniques – with 520 safety assessment methodologies identified for supporting air traffic management (Everdij, 2004). Although awareness and understanding of the practical application of such a great number of techniques may appear impossible, it should be emphasised that not all the techniques are discrete, with many variants evolving for a subset of the techniques. One idiosyncrasy of safety assessment techniques is that there is a popular trend to give the techniques acronymic (HEART) or initialistic (HTA) names. Therefore, often techniques that are identical in form have been given different names due to application in different domains or have minor changes made by authors. Conversely identical techniques have evolved with slightly different names – e.g. Safety barrier function analysis (Kecklund et al., 1996), accident evolution barrier analysis (Svenson, 1991, 2001), energy barrier analysis (Rahimi, 1986) and barrier analysis (Hollnagel, 2004). Kirwan (1998a) outlines an approximate evolution relationship of many of these techniques (e.g. FMEA, HAZOP and event tree based techniques) including cross-links between these.

Even in industries more familiar with reliability engineering techniques, it has been speculated that these techniques were used so scarcely due to the unavailability of the means and/or techniques, technique complexity (Paz Barroso and Wilson, 2000) or lack of information on resources required (Ainsworth and Marshall, 1998). Pradhan et al. (2001) suggest the cultural norms of healthcare also add to the challenges – perhaps resulting in demands for tailor-made instead of the industry standard techniques.

The continuous professional development required by healthcare professionals is broader than the remits of safety assessment. Even with governmental support, this may limit opportunities to learn a range of safety techniques. It may be preferable for healthcare users unfamiliar with the field to choose a technique to solve a specific problem and then target the technique education accordingly.

Otherwise, there is a danger that novices are using techniques to guide safety-related decisions without the training appropriate to

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gain the validity and reliability assumed from the technique (Stanton and Young, 2003).

Whilst there have been a number of reviews of the human reliability analysis and similar techniques (Everdij, 2004; Humphreys, 1988; Suokas, 1988; Kirwan, 1992a,b, 1994, 1998; Stanton et al., 2005; Wreathall and Nemeth, 2004), most have focussed more on the accuracy and reliability of the techniques rather than the requirements of the problem to be analysed. Together with the issues of a lack of technique awareness and expertise, the pressures on healthcare personnel will tend to make healthcare professionals more reluctant to invest in the rigorous education requirements for the more complex techniques, designed to produce more accurate results. This may lead to personnel choosing the "quick and dirty" techniques even if they are not the most appropriate for the problem. Furthermore, the previous reviews have always been written in a technique-by-technique format thus demanding time commitment in investigating techniques that would not be chosen, simply to identify the technique that best matches the features of the chosen problem. In many cases, this assumes the readers to have some knowledge or experience in the field and already have a mental model of many or all the techniques. In short, what is required is a user-focussed approach for selecting a technique – namely a bottom-up method of selection based on the resources, constraints and requirements of the user.

As yet, there has been no dedicated study to research the usability of the techniques, the limits of requirements for each technique in terms of time or human resources or any efforts to support the novice in selecting a technique to analyse their problem. Therefore, this paper provides a first step in providing a literature-based framework for selection of techniques.

2. Terms and definitions

Sources of confusion are the terms and definitions used when describing the techniques. Therefore this section provides a cautionary word about the "idiosyncratic" use of acronyms and initialisms within the field. (A full list is shown in Lyons et al., 2004b.) Tools, techniques, processes and methodologies are used interchangeably within the literature. However, for the benefit of this paper, the term "process" will be reserved to mean the "clinical process" under assessment for its risks, i.e. "the process of inserting a cannula", "the process of prescribing drugs", "the process of resuscitating a patient" or "the process of organising a referral". The "system" is defined as "a set of connected items or devices which operate together". This is the term used to represent the "actors" carrying out the processes or influencing upon it, including the work environment, people and equipment.

3. Method

This paper aims to cluster the information in the literature to provide an initial framework to support novice users in selecting a technique for use.

The findings of a previous review of the literature (Lyons et al., 2004b) were used to structure the framework. These had been reviewed by the author – an individual with over 10 years experience in human reliability and safety. Acknowledging the findings of Everdij (2004), Suokas (1988) and Kirwan (1998b), this included a search using 168 generic and specific search terms on Embase, Ergonomics abstracts and Medline to identify HRA techniques. The generic search terms included "error identification", "human reliability" and "patient safety"; whereas the specific searches included the technique names and their acronyms. For each result identifying more than 100 references, only the first 100 were included. From this, the cumulative searches, performed in November 2003, found in excess of 8000 abstracts which revealed 134 techniques for use in predictive safety/human reliability analysis. These were screened according to the following criteria:

- Conceptual models that were not demonstrable in practice were eliminated from the list (SCFM).
- Generic descriptions or toolboxes were eliminated – e.g. root cause analysis or probabilistic risk assessment were broken down to the original techniques.
- Highly developed domain specific techniques were excluded if it was deemed unlikely that they could be converted for use in healthcare (or if conversion would mean building the technique from first principles or from a more generic HRA technique that had already been included in the list).
- Computer-based or simulated versions of methods were included in terms of one base method – not as individual methods – where methods were duplicated in different versions, the version showing the greatest potential for use in healthcare was recorded (e.g. THERP rather than ASEP, SHERPA rather than PHEA).
- Methods that were only data collection (e.g. questionnaires, interviews) were eliminated from the list.
- The technique must appear in more than one paper (thus demonstrating at least presentation of a technique and ongoing use beyond this). Some leniency was given for methods highlighted in recent publications that did not fail totally on the other criteria and could be representing an emergence of a popular new method (these were EOCA and TraceR).

This resulted in a shortlist of 35 techniques. On a technique-by-technique basis, all the relevant papers identified were collated. From each paper describing or reviewing the method in theory or practice, any data that would guide the selection in terms of resources, constraints and outputs were recorded. These were broken down to clusters of information on time and nature of expertise. Also, being a critical aspect of the method, the nature of the information was analysed to identify generic categories. These included consideration of which aspects of the process were required – for example, data on the physical or cognitive aspects of the task. This also concerned the nature of the situation under assessment; whether, at the start of the analysis, there was only information on the "normal" running of the process, whether this was focussed entirely on an abnormal situation or whether both aspects were required. Because this work was aimed at novice users, where a technique could incorporate many of these pieces of information or run adequately with minimal input, each technique was interpreted and categorised in accordance with its simplest form. For all of these features, All variance or discrepancies were noted and recorded – resolving where necessary through checking consistency with the original "first published" version of the technique. The data for the technique were then positioned in each part of the framework as shown in Tables 2–8.

Because of the delay between this initial review and the decision to publish the framework, this review was updated (performed June 2007) to ensure that this had included more recent techniques and method/review papers. Therefore this review used 176 search terms – due to the author's increased awareness of additional techniques. This time the focus was moved to focus on the open source databases that were well used and trusted within healthcare – Ovid incorporating Embase and Medline. Over 8000 references were identified in this search – shortened to 2516 for initial relevance to the topic area, finally identifying 80 papers highlighted as having potential relevance to providing information that would support novice users in healthcare to use the techniques (either techniques reviews or descriptions, or example applications of the techniques).