A transdisciplinary approach to reducing workplace injury through the use of coronial reports

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Abstract: *The concept of the engineering profession working with the Coroner in an attempt to reduce the rate of injury in the workplace is presented. The paper briefly looks at the role of both the engineering profession and the coroner in relation to safety. The output of the coroner – findings and recommendations following death – is considered as an input to engineering design. Two uses of the coronial information are suggested. Those are case studies in undergraduate education, and the development of publicly accessible databases identifying root causes of workplace accidents. Current work in both areas is presented. All this is presented with the background of a transdisciplinary approach.*

Keywords: *design, safety, coroner*

The Engineering Profession and Safety

The Engineering profession sees itself as providing a service to the community. The Code of Ethics of Engineers Australia, specifically says that engineers must put the interests of the community ahead of any other parties. As a profession, engineers have been addressing community issues for many decades. The recent emphasis on sustainability as the driving factor behind decision making only reinforces this concept.

If it is recognized that sustainability balances on the three legs of economic, environmental and social agendas, then it is easily seen that social responsibility is now a vital factor in any engineering decision. When we consider social responsibility, we must realize that it includes the broader area of community issues as well as the narrower area of the individual. However these two concepts are not mutually exclusive. As the profession is already geared toward considering the broader community issues, it is now worthwhile considering what issues impact on the individual, and how they are to be reconciled with the issues of the community.

One important area that the profession can address immediately is the issue of health and safety. The National Occupational Health and Safety Commission (NOHSC) echoes that sentiment in identifying safe design issues (including engineering design) as one of five national priorities in reducing death and injury over the next decade. In 2000 NOHSC conducted a review of workplace deaths (NOHSC 2000). The review suggested that in Australia there are on average 10 deaths per week in the workplace. A large proportion of

these can be traced back to poor design of equipment or systems. Poor design in this case does not mean technically poor, but poor from a user's perspective. All design must address both technical and user issues. For this reason this paper will focus design rather than other aspects of engineering.

The Coroner and Safety

The Engineering profession is not the only profession to recognize its responsibility toward health and safety. According to Johnstone (2002a, p30), about 7500 violent, unnatural or accidental deaths are reported to Australian coroners each year. Of these, approximately 200 are homicides. Johnstone goes on to say that

> *... Whilst the coroner's work in the area of specific unsolved or 'hidden' homicides is important…it is in the area of health and safety that there is a need for a far greater level of work.(Johnstone, 2002a:30)*

Coroners have historically been seen as people who apportioned blame after an accident. Through their work however, it has been realized that many deaths throughout Australia and New Zealand repeated the same root causes and industry was not learning from the deaths of individuals.

A Transdisciplinary Approach to Safety

So here we have two professions who are both aware of their social responsibility in the area of health and safety. One group has the ability to reduce hazards in the community, and one has the ability to identify hazards in the community. This suggests that there should be value in the two professions working together. Once we start considering having various professions working together toward the common goal of health and safety, there is a third obvious group that should be included, and that is the Health and Safety (OHS) professionals. This brings together an interdisciplinary group to address the issues. However if a transdisciplinary approach was used, there could be learning within the professions as well as problem solving.

A transdisciplinary approach is an approach that fosters joint solving of complex problems across science, technology and society. Transdisciplinarity requires that stakeholders participate from the beginning and remain active over the entire course of the project and mutual learning is the basic process of exchange, generation and integration of existing or newly-developing knowledge in different parts of science and society (Klein et al, 2001).

So how can the professions benefit each other? From the point of view of the engineers and the health and safety professions, what are the benefits of Coronial inquiries, in Australia, for the community? The benefits of in depth coronial inquiries to the community are many and varied. However we see the principal benefit of 'in depth' coronial inquiries as being the ability for the Coroner to conduct the inquiry in an interdisciplinary environment, without the burden of apportioning blame. This allows the Coroner to identify the root cause (both direct and system wide failures) of an accident, so that issues can be acknowledged and addressed.

Benefits to all stakeholders

There are many benefits that can be derived from this approach. The obvious benefactors are the workers who stand a chance of working in a less hazardous environment and to go home safely to their families once more. The other winners are the employers who will reap the

rewards of good corporate citizenship and less chance of prosecution or litigation. However, the professional groups also gain significant rewards.

Benefits to the Engineering Profession

The engineering profession can benefit, by furthering its' understanding of how and why accidents occur, and the nature of safe design. The profession prides itself on improving the human condition and having community interests at heart. Engineering designers do not purposefully build hazards into their products and systems. However, there have been many cases of similar accidents or disasters occurring in different products or systems, indicating that designers do not necessarily learn from the past.

High profile disasters that have had similar root causes are the cases such as the Piper Alpha oil platform fire and the Esso Longford explosion (Johnstone, 2002b). Both of these cases had frighteningly similar technical and communication root causes. While major disasters are normally known of and discussed within the industry in which they occur, disasters and accidents with similar root causes can occur in different industries. Accidents involving only one person may not even be heard of outside the workplace in which they occur. Designers need to be aware of previous incidents and disasters.

So how are engineers expected to learn from the past? A designer may be conscientious about health and safety, but how can individual designers be aware of a root cause that occurred in another industry? By learning from coronial reports, the profession can ensure that safer designs are the norm, and so create a safer environment. In doing so, community trust in the profession is enhanced and consolidated.

Benefits to the OHS Profession

Effective Occupational Health and Safety management depends on useful and timely anticipation of hazards in the workplace. The OHS profession is able to use the findings and recommendations of Coroner's inquiries to inform the design of management systems, workplace practice and environments. This allows the profession to assist organizations to learn from accidents without repeating them.

The coroner's cases are also used in the classroom to prompt problem-solving activities that replicate the real situations that students may find themselves in. They are able to practice many of the core skill set, for example, writing legal position papers, investigating accidents, developing an understanding of direct and latent error sources, and applying their knowledge of hazard control. Context is extremely important in OHS education and practice. Learning from Coroner's inquiries allows students and practitioners to hone their skills in a safe and non-threatening environment.

How Can the Coroner Contribute

The next generations of the professions must be educated. If cultural change is to occur, then the next generations of the professions must be the drivers. To do this, the resources must be there for them to use in their learning. The resources include availability of case studies and databases. The use of case studies to demonstrate how people can be injured, and how systems can be designed to ensure they are safe, is vital. The undergraduates also need the opportunity to work in interdisciplinary or preferably transdisciplinary teams. If this is done at undergraduate level, it becomes easier to work in this manner as a graduate.

The outcomes from the Coroner's reports – the recommendations – can provide a stimulus for treating problems at the system level, which has great potential in the prevention of accidents. Engineers have a duty of care to end users of the systems they design under current statutes and at common law. That engineers contribute to human error in systems through latent design error and poor management decision-making is well documented (Toft, 1999). Therefore, the role of engineers can be considered integral to positive outcomes in safety.

Ultimately, it reasonable to expect, that when engineers have a better understanding of the human component in their system designs there will be reduced design related human error, therefore, better health and safety of Australia's workforce and community in general. The 'in depth' Coroner's inquiries can fill this much needed gap in knowledge.

A further benefit of the 'in depth' enquiries is that the reports become public domain, and therefore can be used as a source for organizational learning, or simply as a source of identifying issues, particularly in design, that must be addressed so that accidents or disasters are not repeated. An example of this is the Linton Wildfire inquiry and report (Johnstone, 2002c). While the inquiry found the cause of death, it also identified some previously unrecognised flaws within the original design decisions. For example, issues such as identifying exactly what volume of water is needed to be kept in reserve for self-protection of the firefighters, rather than just a percentage of a tank. The rule of thumb that the firefighter worked on was to keep ¼ of a tank in reserve to use as an umbrella for self protection should they find themselves in the path of the fire. As various tankers have different size tanks, using a percentage of the tank means that the different tankers have different levels of self-protection. The coroner's recommendations also highlighted unsubstantiated assumptions as to how much water is actually required for self-protection.

The inquiry also identified that there had been no research to identify exactly how much water was needed for self-protection. In this way, the Coroner's findings and recommendations can inform the future and direction of community centred research. However, the effectiveness of this potential learning is dependant on whether allied professionals are able to access and use the information, and on the quality of the reports.

The outcome for the community in general is then an improvement in the products and processes that are made available, and the confidence to know that accidents should not be repeated. This should be possible where there is a detailed documented analysis of how the event occurred and where the Coroner makes recommendations. For example, the cause of the series of Mistral Fan fires was identified through the detailed analysis of seemingly unrelated cases (Johnstone, 2002a). It was the Coroner's "bird's eye view" of the commonalities within the cases that led to unravelling the mystery. It is through the recommendations that action is identified and made possible.

How Can the Coroner's Data be Used?

The following section outlines some uses for the coroner's data. New and creative uses are encouraged so these examples provide a starting place only.

Undergraduate Education

Engineering undergraduate programs have traditionally valued and emphasized technical excellence, and so they should. This has resulted in graduates who are technically proficient, and consequently looking for technical solutions to community problems. The emphasis within the profession on sustainability has however led to recognition that if graduates are to

be socially responsible, then they must address social issues at the undergraduate level. This is evidenced in the current accreditation requirements by Engineers, Australia, for engineering programs in Australia (IEAust 1999).

Engineers as designers have a responsibility to ensure that the designs that they create are safe for the users. Unfortunately engineers, being people, are only able to create safe designs based on their knowledge and understanding of what is safe. This knowledge is often developed through experience, and through learning from the past. If disasters, and their causes, along with the issues raised are kept hidden, or not fully investigated, then it becomes difficult to learn from the past. Traditionally engineers have been taught that designing to Australian Standards will ensure a safe design. Standards have been proven to be inadequate at times, and a reliance on them can be dangerous. Development of coroner's reports into case studies that would inform educators and provide a learning stimulus for students is one potential use of the coroner's data.

This approach would afford engineering students the opportunity to practice 'risk management'. The following is an excerpt from a lesson plan using the Linton case study as an example from our own teaching:

> *How could an engineer have been expected to anticipate, identify and act on these issues? The following process provides a useful guide. The main steps in the process are:*
>
> 1. *Anticipate and identify hazards*
> 2. *Assess risks that may result because of the hazards*
> 3. *Decide on control measures to minimise the level of, or eliminate, the risks*
> 4. *Implement control measures*
> 5. *Monitor and review the effectiveness of the implemented measures.*
>
> ***1. Anticipate and identify hazards***
>
> ***1.1 Thorough problem definition.*** *At the design stage, problem definition itself has to include more than the technical specifications. It should also include*
>
> - *A thorough understanding of all tasks involved.*
> - *A thorough understanding of the intended environments.*
> - *User requirements eg. Information on when tank is at low level.*
> - *Recognition that the designer is not normally the typical user. Therefore the designer needs to consider the user in the design process. This can be achieved by:*
>   1. *Consultation with typical users (not just their supervisors).*
>   2. *'Walkthroughs'–these could be computer generated simulations or even a simple mental walkthrough of actual usage, preferably with a potential user.*
>   3. *Looking at the way people actually interact with similar pieces of equipment i.e. the model of usage for similar tasks or control configurations.*
>   4. *Talk about any problems the user has using current equipment in their workplace.*
> - *Use the human factors advice available, for example HB59 Human Factors (Australian Standards Handbook)*
>
> ***1.2 Learning from the experience of others.*** *Use this information to inform future design. For example:*
>
> - *Accident reports*

- *Safety alerts from the various state and federal government agencies responsible for OHS (e.g. NOHSC– all others jurisdictions can be found from NOHSC website)*
- *Coroner's reports*
- *OHS Practical Solutions database (NOHSC website)*

2. Assess risks that may result because of the hazards

Many factors must be considered when assessing risk.

- *Nature of the* ***environment*** *in which the design will be used (contextualise the actual use of the design) for example in this case consideration that the operator would be concentrating on putting out a fire, not watching a gauge.*
- ***Processes*** *carried out within that environment, that is, did the designer consider any other operations in the environment that might impact on the safe operation of the equipment? (e.g. desealing/resealing of the tank, and workers exposed to a cocktail of hazardous substances.)*
- ***Characteristics of the users****, such as age, anthropometrics (size of people) level of skill, knowledge and experience. For example, how did the design take into account the various people who might be using it, and how differences between those people might change the way they carry out the process.*
- ***Existing hazard control measures*** *and their effectiveness. For example, have any accidents ever occurred previously in similar fires?*
- *Consider the* ***range of environments*** *in which the design will be used. In this case they could range from grass fires to forest fires and house fires; in flat of hilly country. Also consider the stress that emergency situations might induce in worker behaviour; other lives may be at stake too.*

3. Decide on control measures to minimise the level of, or eliminate the risks

- *Revisit the hierarchy of control, and ensure that control measures are aiming at the top, not the bottom of the hierarchy. Eg, in this case realise that if the ¼ tank rule is taught then people will expect teams to use it, but this is use of PPE. So elimination of the hazard in this case would mean not needing to use the ¼ tank rule.*
- *Controls must be based on a life cycle approach. This means that the concept design phase is the ideal place to consider identifying hazards and appropriate control measures.*

4. Implement control measures

- *Systematic evaluation of both the probability of a hazard occurring and consequences of injury or illness that may arise from exposure to identified hazards is the central mechanism for applying the OHS hierarchy of controls.*

5. Monitor and review the effectiveness of the implemented measures.

- *It is important to ensure that you are not introducing new hazards into the system as you plan and implement the controls. The risk management process is an iterative process, and each of the steps should be applied until you are sure that new hazards no longer exist. This is a continuation of the concept that the design process is an iterative process.*

While construction / manufacture and maintainance are important areas of engineering, the focus of the learning experience has been on the use of the risk management process to improve design. This enables students to work at the top of the hierarchy of control measures as a first option for elimination of hazards.

User Friendly Databases
If the engineers and the health and safety professionals are to learn from, and work with the coroners and each other, there is much groundwork to be covered. A common language must be developed (Toft, Howard and Jorgensen, 2000). Even in disciplines where similar language and approaches are used, the same words can have different meanings, and communication becomes an issue.

The knowledge and databases must be developed. If the engineers and health and safety professionals are to learn from the coroners, the information must not only be available, but available in a format that can be accessed and used. Coroner's reports have findings and recommendations that are usually filed and go unimplemented by the vast majority of industry. The company that is affected by the death is usually the only company that implements the recommendations from the inquest. Companies not associated with the death can prevent many failure modes by learning from the death of an individual. The National Coroners Information System, while a commendable project and eminently suitable for its intended purpose, however is not a suitable tool for the designers to use.

If a designer is looking for potential hazards in a new product or system, it would be of great value if they could access a database that identified where accidents had already occurred. As the designer is not usually a typical user, their familiarity with the system can (and does) easily lead to overlooking hazards. While they could work with a health and safety professional to identify hazards, access to databases of previous accidents would only add to the safety of the design. The information in the coroner's reports can provide the basis for such databases.

Current Work

Undergraduate Education
As a research team, we have used information from the Coroner's reports to build case studies of poor design in relation to safety. This work was funded as part of the NOHSC Safe Design Project. The publication we have recently completed is to be called "Occupational Health and Safety for Engineers – A resource for engineering education".

This series of case studies is aimed at demonstrating the multi factorial nature of accidents, within the context of real environments, with all the inherent complexities. It is expected that the use of such case studies will go towards the development of engineering graduates with a more holistic appreciation of the interaction between people and the products, systems and processes that engineers design

The types of cases (Coroner's reports) that we used are those that have poor design as a root cause. Poor design does not necessarily mean technically poor, but poor in terms of usability or the way in which people react with the product or process, or the way in which the project is managed. We also looked for real situations, with real people, telling a real story. The reality is very important for the students to understand the human in that situation. The reality also helps the students realize that this is a situation that they, as designers or managers, could find themselves in. It also challenges their developing sense of ethics.

User Friendly Databases

This research team is now involved in the CRC - Centre for Integrated Engineering Asset Management (CIEAM). There are currently two projects run by this team that have emerged from that association. They are:

- a pilot project to deliver workshops to industry partners on the use of the coroner's data to prevent accidents through design, and
- a project working with Ford Australia to bring a database of root causes of potential hazards based on coronial data to the Central Queensland University web site.

These projects came about because the Plant Manager and the Corporate Manager of OHS for Ford Australia approached the State Coroner to gain input to setting up a project whereby all industry would learn from the mistakes made in industrial deaths. Ford Australia would set up a database and input all historical data, findings and recommendations from Coroners findings all across Australia. The information would be shared amongst all industries. The State Coroner was supportive of the project and lobbied other State Coroners.

At Ford Australia, a team was formed to establish the techniques for collecting the data, and developing the database. The result is a database that can search on keywords, incident type or incident title. The database's central location was Ford Australia, but it was hoped that a Government Agency would host the database on their web site for all industry to access. CQU has become this partner.

The measurable results from the collection and logging of the data to date is as follows:

- Over fifty cases have been identified and logged onto the database
- Over 300 findings logged
- Over 600 recommendations to avoid industrial death thus far
- Historical data has been loaded from the Australian states of Victoria and South Australia and from New Zealand.

This database has already helped Ford Australia identify the size of manholes as a safety issue. It was identified through deaths in a number of confined spaces that manholes, even if designed to the appropriate standards, could be a hazard particularly in a rescue situation.

Ford Australia as a result of some of the findings and recommendations has reviewed and implemented changes in the following programs:

- Size of manhole covers
- Confined spaces
- Auditing processes
- ECPL procedural review.

Funding has now been obtained to develop and host the Ford database on the CQU website, to allow public information to the information.

Conclusion

The concept of the three professions learning together as an interdisciplinary group could have positive outcomes for the community. However, the real differences will be seen when the transdisciplinary teams of the three professions start working together to develop and implement solutions. The community problem has been identified – safe products and systems are required. The solution is not so easy. What is required is a cultural change

within the professions. While the governing bodies, for example Engineers Australia, may require its members to produce sustainable designs, if the knowledge does not exist, then the outcome is difficult.

Socially robust research in this area will require several prerequisite conditions for success. The most important being good quality investigation and reporting, that documents are public domain, and ensuring access to the learning occurs across professions and industries.
It is vitally important that the neutral community partner (the Coroner) has a voice that can provide credible advice and inform change. That the loss of life is not in vain, but that the living can learn from the findings and recommendations, is possibly the greatest benefit for the community.

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