THE ROLE OF DESIGN IN OCCUPATIONAL HEALTH AND SAFETY
A discussion paper

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Abstract - Design is the key: it is at the design stage of any project, be it large or small, that we are presented with the greatest opportunity for injury prevention, or, alternatively, as we often see, through inadequate attention to design, in fact *ensuring* that serous injury will be an inevitable outcome. Design issues, as well as the changing role of engineers and other designers as regards responsibility and accountability for safety over for the full product life cycle, will be discussed.

INTRODUCTION

This paper examines the issue of the role of 'design' in Occupational Health and Safety. My unequivocal view, formed after many years as both a design engineer and accident and safety researcher, is that design is central to safety. Injury results from the interaction of humans with products, process and the environment. One can either adopt the moralistic and simplistic 'blame-the-user approach' to injury prevention, or recognize this approach as camouflage for poor and un-professional design. Failure to recognize the role of design in contributing to serious injuries simply protects those responsible for design and manufacture and purchase, and regulation. Clearly and tragically, failing to recognize the role of design in injury causation also ensures continuation and repetition of injury causing incidents, as we see almost daily.

Design is a broad ranging term, and here I include the design of products, equipment of all types, processes and the constructed environment.

Yes, we have all heard that in over 90% of incidents human 'error' or at-fault behaviors have been identified as a causal factor in incidents – but this type of statistic (and inference) misses the point entirely. To me it simply reflects that an incident cannot occur on its own (except for mechanical failure) and that of course for an injury to occur humans must be involved.

The '90% human error' view, also fails to properly consider that any activity is based on some form of partnership between the human operator and the equipment or process undertaken. In this 'partnership' the human becomes the flexible partner or 'bridge' who must make up for any deficiencies in the equipment or process undertaken. The better the design, I suggest, the less the human must stretch his/ her resources, and the less they are at risk. Some would call good design simply a matter of good ergonomics, but I think it is more than this.

It is interesting to consider Shoshana Zuboff's [11] idea that all work 'depletes' the body in some way. This idea is clearly central to any consideration of OH&S. Zuboff goes on to say that in the "*world of production, where primary materials are processed and goods are manufactured, has long been marked by a great divide between those who give of their bodies and those who are exempt from physical depletion. ...Workers facing the physical requirements of labour seek ways to preserve their bodies from exertion, while managers are charged with extracting the maximum feasible effort from the workforce*"

My perspective[1] on the idea of 'work depleting the body' is that the better the design the less

The question arises, then, how good can any current design be? Well, we clearly are constrained within current technology and knowledge, irrespective of cost considerations. It is simply a matter of looking back at designs which are 10 or 20 years old, and recognizing that improvements have occurred since then. A tractor from the 1960's does not look a lot like a tractor from the year 2001! Yet from a safety viewpoint there are still cases of ongoing and glaring deficiencies (e.g. fittment of ROPS [1], access provisions or suitable passenger provisions), which largely reflect a lack of safety focus, or accountability, or specific quality performance requirements. The interesting question to me is how much can we, from a safety perspective, accelerate the change and improvements: clearly we could not have designed a 2001 tractor in 1960! I think we can make significant safety design improvements, but it requires both knowledge and power, the latter factor often lacking by safety advocates.

We only need to consider the efforts required during the 1960 and 70's to improve vehicle design for improved occupant protection and crashworthiness, and the major advances made through to recent times. Catalysts such as Ralph Nader's book 'Unsafe at Any Speed' and subsequent introduction in the USA of specific performance requirements in terms of Federal Motor Vehicle Safety Standards (FMVSS), totally altered the auto vehicles safety landscape. In more recent decades consumer based testing of vehicles and other products has propelled safety advances even further.

Whereas standards for automobiles provided specific levels of performance to be met, in the 1970s we saw OH&S regulation moving virtually in an opposite direction under the Roben's style regulation. This led to general 'duty of care' and risk based processes for addressing safety in the workplace. In my opinion, this approach has hindered the opportunity for safety advances to be made in many areas. Rather than harnessing the collective energy and expertise of industry and professionals in each field, the risk assessment process mandated under OH&S legislation in Australia, helped ensure fragmentation of energy, resources and expertise. It left the onus on each workplace (irrespective of it level of resources or expertise) to decide what was 'safe', a condition which clearly can be in the eye of the beholder. It also left in place the issue of who is at risk and who makes the decision about reduction of risk. Often the manger (who is not at risk of injury) can easily discount or rationalize the risk to the person at risk.

Whereas many risks are common and shared through out industry groups (e.g. falls from height in domestic construction), the mandated risk-assessment processes rather than tackle such risk on an industry wide basis, became the province of thousands of builders, hundreds of times over. And of course the acceptable level of performance[2] under such a scheme could only be really be established by the Regulator *after* an incident occurred!

[1] Although this may sound emotive and possibly political, I regard it as neither. It is simply and importantly a powerful expression of what I think we are really dealing with in Occupational Health and Safety.

[2] The so called "Performance Standards' are often nothing of the sort, in my opinion. Genuine Performance standards set specific requirement in terms of quantitative measures, not general 'duty of care' requirements. I would suggest that the most effective requirements are "duty of care' obligations supported by real performance standards, backed up with effective compliance control and sanctions.

BLAMING THE VICTIM, THE ROLE OF DESIGNER'S AND 'VISION ZERO'

Injury represents a failure in some part of the work system. A system consists of people interacting (working) with the environment. It is self evident that injury can not occur unless people are present, hence the often quoted - and largely misunderstood and misrepresented fact - that human error is the causal factor in 90% of the accidents, implying that if people were 'more careful' then we would have many fewer accidents!

Blaming the victim has a long history, and continues to provide considerable hindrance to advancing injury prevention activities and helps to obfuscate the actual *causes* of death and injury. Wiggelsworth [10] summarizes this well in his description of the historic "behavior centred approach" for explaining diseases (disease resulted from *faulty* behavior) verses the relatively recent scientifically based "environment centred approach". Wiggelsworth notes that:

> *"..as the tide of infectious diseases has receded ....there has arisen in its stead another epidemic that of accidental injury. Confronted with the similar devastating proportions of this new epidemic, we have in dealing with it reverted to the beliefs, attitudes and mindless philosophies of earlier ages. We may no longer treat the plague by punishing its victims or trying to prohibit faulty behavior, but we nevertheless retain the concepts of fault and negligence as the salient features of contemporary injury analysis, and advocate the adoption of punitive measures as a primary method of treatment."*

The scientific approach to accident prevention recognizes that there is usually a multi-factored chain of events leading to the 'accident'. Although one of factors must at least involve humans, effective injury prevention strategies (Haddon's Matrix), address all three major factors in the injury chain - *the host* (person), the *energy source* (machine, load etc) and the *environment*.

It also recognises that humans can not perform 'correctly' 100% of the time, and thus the need to properly consider "passive" strategies in which the system design is changed to protect automatically the population at risk, without each vulnerable individual having to take action. That is, 'passive' strategies are favored over 'active' strategies which rely on individual behavior, and consequent need for being robot-like in terms of error-free vigilance.

Vision Zero

Probably the most complete and far-reaching expression of the role of system designers in safety is that formulated in Sweden's 'Vision Zero' Road Safety philosophy. There are no obvious reasons why the same sentiments could not be applied to OH&S.

The underlying premise for 'Vision Zero' is that "*no foreseeable accident should be more severe than the tolerance of the human in order not to receive an injury that causes long term health loss*". Adoption of this philosophy, as has occurred in 1997 by the Swedish Parliament [9], clearly has far reaching ramifications in terms of system design requirements. It moves totally away from the 'blame the victim' viewpoint and explicitly recognises that responsibility for safety is shared by the system designers and the road users. It sets out three principles in this regard, the first of which is:

'The designers of the system are ultimately responsible for the design, operation and use of the road transport system and thereby responsible for the level of safety within the entire system'.

The other important aspect of 'Vision Zero' is that it introduces '*ethical rules'* to guide the system designers. Tingvall sites two examples:

- *'Life and health can never be exchanged for other benefits within the society'*

- *'Whenever someone is killed or seriously injured, necessary steps must be taken to avoid similar events'.*

Vision Zero boldly moves away from the economic- rationalist 'cost-benefit' models that are used widely in many injury prevention arenas, to a humanistic (and more rational!) model. This is indeed, in my opinion, a move that should be much applauded.

SOME EXAMPLES OF THE ROLE OF DESIGN IN OH&S

The key role design plays in OH&S has been identified in numerous studies. To illustrate this role, findings from four studies (forklift safety, heavy vehicle safety, manual handling and, construction industry safety), are briefly presented.

(i) Forklift safety. This study [8] identified that one of the main injury problems related to pedestrian workers being struck by forklifts. The study identified that whereas the main industry focus (including that of the relevant standards) was on driver behavior, the fundamental problem lay with a lack of traffic management systems within facilities. Specific recommendations included:

"Forklift trucks be recognised as a "heavy goods vehicle" which require appropriate facility design for their operation. Develop industry specific models for the layout of new facilities which incorporate the principles of effective traffic management and separation of forklifts, pedestrian and other traffic."

(ii) Manual handling injuries and slips and falls from transport vehicles. In a major study [3] carried out for the VWA in the Ballarat Region, looking at transport activities, it became clear that the main safety issues were related to manual handling, and the associated slips and falls from vehicles during manual handling. Two of the conclusions from this study were:

1. Personnel access provisions to truck cab and load area are typically very poorly designed, inherently unsafe and generate slips and falls from the vehicle.

2. Current truck design makes very little provision for aiding loading and unloading in distribution, which is typically manual with no mechanical aids,

This study resulted in the production of the booklet **Safety By Design: How to reduce injuries in Manual handling and transport**' [4] published by WorkCover (Victoria), aimed at assisting vehicle designers, owners, manufacturers, and fleet operators to improve the ergonomic design of freight vehicles and associated facilities.

(iii) Manual handling Risk assessment in Manufacturing Industries – a focus on Women. This study [2] examined the effectiveness of the prescribed processes and tools for carrying out manual handling Risk assessments in the workplace. One of the conclusions related to workplace design and layout:

> **"Workplace design and layout.** For some of the workstations assessed in this project, inadequate attention appeared to have been given to the needs of the operator to carry out the tasks efficiently, with a low risk of manual handling Injuries. In these instances, the operator's work position and space represented a minimal and ergonomically inadequate layout. This suggests that the operator was an appendage to the production process and, at times, even an afterthought. In other situations, the operator was considered (by implication) to be a very flexible tool who was able to bridge the gaps in the production process. These gaps were created as a result of inadequate thought being given to the design of the production system in the first place. There was clearly lack of adequate consideration given to ergonomic design in many cases, with the urgency of production requirements apparently overriding other considerations."

(iv) Safety in the Construction Industry. In a large study carried out by MUARC[3] for the VWA, the priority injury risks identified related to falls from height, manual handling and contact with power tools and other equipment. A conclusion reached in regard to reducing injury risk, related to the key role of designers and architects:

> **"Lack of Designer & Architect OHS consideration (and accountability) for erection and maintenance, and downstream risks.** Many risks to which construction workers are exposed to are in part dictated to by the design of the particular project. These risks can be overcome or reduced by rethinking designs to take into account OH&S considerations. In other words, there is a lack of accountability for injury risk by system designers. That is, architects and engineers are not required (typically) to consider constructability or operation and maintenance *in terms of OH&S risk.* A holistic view needs to be developed whereby due consideration is given to downstream consequence of any design:
>
> - exposure to injury risk during construction
> - exposure to injury risk during operation
> - exposure to injury risk during maintenance
> - exposure to injury risk during refurbishment/ demolition
>
> The tendering process can also lead to separation of the design from the construction process, thereby further removing the scope for construction personnel to reduce injury risk during construction, by design changes."

SAFETY IN DESIGN – SOME BASICS

Good safety design requires firstly, and fundamentally, an understanding of the performance requirements for the particular system. Although this may appear self-evident, good performance specifications take some effort, and it is at this point that we see that safety risks will be either built-in or largely eliminated. As it is at the 'design drawing board' stage that a physical system is really created, if safety is not properly considered, then we are simply planting the seeds for future incidents. Incidents resulting in serious injury are an inevitable outcome of such a design, and it simply becomes a matter of time and exposure by 'players' in that system before an injury will occur. If an incident investigation is carried out, it may typically only consider the tail-end of this whole process and then largely attribute the incident to 'human error' or alternatively, to being a 'freakish, one in a billion chance

Thus the second aspect of achieving safe designs is the diligent investigation of incidents, be they 'near misses' or otherwise. Good accident investigation [6, 7] requires appropriate expertise. Accident investigations are really part of a Quality system approach to any design, and as such are clearly vital. It is by thorough incident investigation that we obtain feedback

[3] Reducing Serious Injury Risk In The Construction Industry.

on system performance, and hence are provided with the opportunity to identify deficiencies, and areas in need of improvement. Taking action on these deficiencies helps ensure that incidents are not repeated or more serious incident do not occur. It is without fail that one reads of major disasters or other major incidents where clear warnings in the form of earlier incidents occurred but were not heeded. However such early warning signs are commonly ignored and misread because of the focus on human error and blame, or perhaps the 'bean-counters'.

A related activity required to ensure good product or system safety, is a proactive system for collecting data on in-field performance. This is simply application of good Quality Assurance practices, but is not commonly seen, in my experience. Here pro-active means setting up an active system for obtaining data on a product's/ system's performance in the field and obtaining information on any incidents. It is amazing the number of product manufacturers who adopt a laissez-faire (passive) attitude to obtain such feedback. In my experience in investigating serious incidents, the typical response will be that 'we have not had any complaints' or no other incident has occurred. When asked what systems they have in place for in fact monitoring product performance, there is usually none other than by waiting for customer complaints! And, quite tellingly, one is expected to take such a response seriously.

CONCLUSION

The role of design (be it products or systems) is central to achieving good OH&S performance. Those responsible for design, be they owners, operators, specifiers, manufacturers, or designers have the opportunity to build-in safety (for the whole product lifecycle) or through lack of awareness in fact ensure that severe injury will be an inevitable outcome of the system operation.

Safe design requires an *attitude* and *understanding* by those responsible in the process - be it managers, manufacturers, specifiers, or designers etc – that it is their actions more than the end users that will largely dictate the level of safety achieved. Without this outlook, the 'blame the user approach', a focus on behavior, or the 'it's a once off, freakish accident' attitude, can only provide a convenient alibi and rationalization for poor design, but not a reduction in fatalities and serious injury.

A 'blame the user' approach may also provide some system designers (in the widest sense) a shield from possible legal liability or other sanctions. There is a clear need for accountability and scrutiny of system designers for the level of safety performance (i.e for injury outcomes) achieved, and to help ensure that the role of design in OH&S is adequately considered.

Good design also requires good information, experience and knowledge. Standards and Codes of Practice which synthesize expert knowledge and provide genuine performance measures, as opposed to general advice and 'duty of care' stipulations, can play a vital role in facilitating this process.

In a well-designed system, the end user must still, of course, play their role diligently, but under such a system, the risk of serious injury should be much reduced.

This view of the centrality of design to safety is consistent with, I suggest, the underlying premises of the 1985 Occupational Health and Safety Act. That is, the implementation of workplace strategies which move industry from the historic and outmoded "*safe worker approach*", to the view that it is more effective to *remove and/or control the hazard* resulting

in a “safe workplace”. This requires the *design* of the equipment and environment so that they are *inherently safe*, or more accurately, expose their users to lower levels of risk.

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