# Controlling people-safety

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ABSTRACT: In a previous article, this author pointed out that engineering can be a dangerous, even deadly, occupation at all levels, trades and professional, and covered that statement by reference to many examples in which injuries and fatalities have occurred, all closely related to the work being performed or to the technological items being used [1]. Those examples are, naturally, factual, from history, and one, a fatality, was used (with some departure from what actually happened) as an incident in a recently-published novel, in which a second fatality was also included [2]. The difference between these incidents was: the first is described as a simple industrial accident caused by the worker, whose action killed himself (as in the historic case, which occurred where the author was employed), and the second is the death of a professional engineer due to a heart attack (again, an item from this author's work-life). The two incidents provide lessons for engineers at all levels, from students through senior ranks, on the importance of observing and interpreting human behaviour so that such occurrences are prevented or at least the effects are minimised.

Keywords: Engineering work safety, risk management, risk assessment, accidents, fatalities

## INTRODUCTION

The drama attached to these events in the novel is, of course, simply *part of the story* and so are the repercussions following from each; the first leads to legal consequences, the second to disturbances in the project's continuing. However, here the author will not consider aftermaths, but wishes to look at the lead-up to each, considers the background causes of each, and what could have been done to prevent them happening. In the real world, of course, such analysis will never turn back the clock and prevent the occurrence, but it is worth doing it to prevent something similar in the future, which is a major intention behind this article, to show, by going over the past, how one can prevent being doomed to repeat it.

Overall, the inherent moral is the same as in the previous article, that engineers' work involves many hazards, so engineers are responsible for ensuring those do not become realities and for passing on the warning to those engineers who follow in the profession.

## THE INDUSTRIAL ACCIDENT

This accident occurred in the 1950s, which is so far in the past to have few others hold memories of it and, quite possibly, for no records to exist. All that is available for this analysis is this author's personal memory, from being an employee in the firm's design department at that time, and hearing what had happened.

If one applies the principle of looking for the event's root cause, one learns that it came from a very reasonable management decision to increase steam availability to cover peak production demands. The company produced chemicals in Sydney's western suburbs on a site housing several plants, some of which operated in an on-and-off manner, causing varying steam loads, generally covered by output from Babcock WIF boilers, but coincidence of demands from plants starting up sometimes caused pressure to drop because the boilers responded slowly to load change. The decision was to install a steam accumulator, a large pressure vessel, which would be filled with hot water by steam injection when demand was low, and which would boil out steam when high demand caused pressure to drop.

When clearing the area for the vessel's location, a large block of concrete was discovered, obstructing the vessel's foundation and an employee (believed to be a qualified rigger) decided to remove the block by pulling it out with a mobile crane. But the crane could not get close to the block for vertical lift, so the crane's rope was at an angle of thirty-to-forty degrees from the horizontal and was pulling the concrete block against the surrounding soil, overloading every part of the crane with the block showing very little movement.

As may be expected, now with the benefit of hindsight, the weakest link in the chain of components failed, and curiously, it was not the rope or part of the crane's mechanism but the crane hook, which straightened, came free and was pulled back by the tensed rope, to strike the rigger in his chest. He died three days later, presumably from multiple injuries.

THE FICTIONAL ADAPTATION

The accident described in the novel is essentially as above. But because the original version was written as a management case study for engineering undergraduate students, two junior engineers were put into the narrative, with one (a young woman) involved in trying to stop the incident from occurring, all to suit the student audience. The incident was retained in the novelised form, with very little addition, and set in a 1950s industrial atmosphere (which, of course, why and how this fictional event was allowed to happen).

THE LEAD-UP TO THE ACTUAL EVENT

As noted above, this article will not deal with aftermaths, but with beforemaths (a word contrived here to suit the occasion), and going back through what happened to the root cause it is quite clear that the fatality would not have occurred if management had not decided to install the steam accumulator.

Were there alternatives? Of course. The obvious one was to install another boiler, which alternative was ruled out at that time, a decision probably based on comparative costs versus benefits.

What other decisions can be found in the lead-up? One was the location selected for the vessel, it had to be close to the boiler house, so it was placed between two buildings where work access was limited, particularly for a relatively large item of hardware, such as a crane. Another was appointing a relatively young, relatively-recently graduated, civil engineer to supervise the project, and one can point to whatever organisation was in charge of the work; historically, a difficult point, because the company had a *works engineering* department, which tended to supervise most maintenance and construction separate from the design department, but for this a contractor may have been used, the crane would certainly have been hired from outside, but whichever applied is unimportant in the long run, because the key factor was the decision made by the rigger who took over on-the-spot supervision and decided to use the crane to remove the concrete.

There was considerable inter-office conversation about the ultimate result, more than gossip, and the one telling item in it was that the engineer in charge of this project was not present at the site when the activity occurred and the rigger was injured, from which there was general agreement that the rigger, himself, chose to try pulling the concrete block, without referring his decision to anyone higher up.

REFLECTIONS

It is now nearly sixty years on from the above. Today's repetition of such an event is extremely unlikely. Why is it so? One can reasonably state that is partly because a much stronger attitude to safety is in place, particularly, when large, powerful, potentially lethal machinery is in use, shown by many factors: our workforce is taught to work safely and the government system (about which one often complains) does its best to enforce safe operations by threats of sanctions, generally fines, for safety infringements.

A much stronger hierarchy within engineering is in existence, and that suggests (at least to this author) that an engineer, supervising such a project, would be on the spot, observing, directing and approving actions when questions emerge. In parallel, today's change in worker-attitude to safety would mean a rigger would ask at least an opinion from a supervisor, safety officer or some such person, before performing such an action. Finally, the firms owning and hiring out mobile cranes control their operation more tightly today.

LESSONS

There are many lessons, which may be extracted from that fatal incident. For example, no-one should engage in any action outside one's own knowledge, and one should be doubtful about anything not covered by reasonable familiarity with details. Hence, here the author points to two such items: using a crane to pull horizontally rather than vertically, and dragging the load through the surrounding soil. And, from that, when in doubt, refer the question to someone else, preferably higher-up.

Unfortunately, both those lessons argue against the notion that people should reason for themselves, make decisions personally, and accept responsibility. All very good and proper, and concerning all that a quote is offered from the chief executive of the company in the novel: *there's a very fine line between a bright guy who can use initiative and a blundering idiot who won't follow procedures*, probably not original from this author but worth noting.

And that leads to the essential lesson expressed very well in a compressed version of the Acceptance Prayer: *God give me the wisdom to know the difference between when I should use initiative and when I should follow procedures*.

THE HEART ATTACK

In the mid-1970s, this author was an engineering manager of a mid-sized chemical production company operating at two sites, each with its own maintenance section led by a foreman. The one at the western site, a Scotch migrant in his fifties, had come from a similar position in a continuous-process plant, which had serious corrosion and mechanical problems. Those had worn him down to mental (and possibly to some extent, physical) exhaustion and resulted in him being dismissed from that position.

He was hired after being unemployed for a couple of months and in the new environment, in a batch process factory, he fitted in well, enjoyed being part of the engineering group and was accepted by the tradesmen under his supervision. His success in controlling the maintenance work was partly due to his nature, that of a *professional worrier*, he took his job seriously and worked hard to keep everything working in good condition.

One morning, he was late for work and a call came from a doctor's office; the general practitioner (GP) informed the engineering manager that his patient, who had called in for just a routine check-up, and while that was progressing he had suddenly said: *I feel cold*. His heart had stopped and although everything possible had been done, he could not be revived.

One of the curiosities of this memory is the GP did not phone the man's wife. This was never explained and, of course, it left that task to be performed by the engineering manager, a necessary action well remembered after several decades. One reads and hears about police and military officers having to pass on such news but rare for others; it is an indelible experience and most particularly so for one to whom it would be unexpected.

THE FICTIONAL ADAPTATION

In the novel, the fatal heart attack occurs during the night, in the person's apartment, where he lived alone, and the news reaches the project office when most of his fellow-workers are together, having the Monday morning conference. Sundry events led to him being discovered, his body is picked up by ambulance and taken to a local hospital, and the phone call comes from the hospital. Enter the woman engineer who is known to be closely associating with the now-deceased instrument engineer: the project manager now has the task given to the engineering manager in the real world, fortunately for him, one of his staff takes over the explaining. In the pages following there is evidence he had a heart condition but exercised extensively, he had decided to *live with it*.

THE LEAD-UP TO THE ACTUAL EVENT

There is enough knowledge of his previous employment to be sure that this foreman had been stressed excessively in his previous position, both by the nature of the beast he had to maintain, and the firm's management, both close and upper, under which he worked. His new position was much more comfortable, less stressful being a batch-process factory, but inevitably, such a position involves some stress, which possibly contributed to his heart failure.

REFLECTIONS

What can be said about this event? As an observer in the workplace? Very little, heart attacks occur, seldom in a doctor's office where one might expect revival could be achieved. What could his manager have done to prevent this death? Nothing at all, the engineering manager knew nothing of the foreman's health condition. Did his manager or others in the department know of his condition, for example, by seeing him taking medication during the day? No, there was no such indication. One can only say any preventative action would have to have been personal or family, initiated.

An interesting literary reflection on this incident is the author's memory, of being the one receiving the *real* news and having to pass it on to the foreman's wife, assisted him in wording the *fiction* situation.

LESSONS

To suggest one should not employ, in industry, people who have any one of the many well-known heart conditions would be unrealistic, because many of those people live to a good age without being subject to heart failure. Certainly, there are occupations in which an unreliable heart is not acceptable, but no-one would include a factory maintenance foreman's position in such a group. However, it is reasonable to suggest that people at the management level should look at more than a subordinate's performance, physical and mental, and emotional condition should be noted.

## AN ANALYSIS OF ERRORS IN THESE CASES

The phenomenon termed *human error* was explored twenty-odd years ago by writers such as Reason [3][4], Rasmussen [5][6], La Porte [7] and others (including Ward [8]), and is essentially simply *making a mistake*. But such a matter is not at all simple, mistakes or errors, can be made in many different ways.

Reason provided a broad classification into *lapses*, errors in the storage or retrieval of data; *slips*, errors resulting from some failure in the execution stage of an action sequence; both of which are *skill-based,* also *mistakes*, deficiencies or failures in selecting an objective (*knowledge-based*) or in choosing the means to achieve it (*role-based*). A further division is *active errors*, providing almost immediate effects, and *latent errors*, the effects of which may not appear for some time. Finally, there is also another possible deviation from an intended path: when someone does something deliberately *wrong*. This can be because that person wanted to try another way of going about what had to be done (action for a good reason), and when the person intended to cause harm (action for a subversive reason). Both of these are *violations*, but as they are not *errors* in the usual sense but something different.

Does the case of the rigger's death fit into any of this? Probably. His action was not a *lapse*, an error in data storage or retrieval, one can conceive he had not information to tell him what he was doing was wrong. His action could have been a *slip* because it caused a failed result. The event could also have been a *mistake*, due to a likely lack of adequate knowledge, and a lack of rules he should follow. Finally, it may have been a *violation*, was he in a hurry to get the job finished before the day's end? Or before his supervisor came fussing around? One does not know. But the rigger's behaviour definitely falls somewhere into *human error*.

Now to the case of the foreman's fatal heart attack. *Lapse*? *Slip*? *Mistake*? It is very hard to fit this into the *skill-based* or *knowledge-based* categories for either the man himself or his manager, perhaps he had twinges, which had caused him to visit his GP. If so, another possibility is he committed an *error-of-omission* [8], by ignoring whatever, perhaps seemingly trivial, evidence he had that *something might be wrong*. However, there is no doubt this fits into the *latent-error* class, of a hazardous condition hidden beneath the normal course of life and requiring coincidence of several circumstances for the fire or explosion or in this case a heart to stop beating, to occur.

## OVERALL LESSONS FOR ENGINEERING EDUCATION

The lessons for engineers from the *crane-and-rigger* case are many and simple: while one may argue such management-safety-action comes from above an engineer's level the engineer, he or she, is the one at the proverbial coal-face or front-line. Hence, engineers must be aware of the rules applying to the work being performed and ensure that knowledge is shared by those actually doing the work; that is, do not leave workers to carry on without clear instructions on what to do and how to do it (and what not to do), by all means use workforce knowledge but direct their activities. How does one impress that on students? Only by including anecdotes, such as above into formal teaching ... by telling what *has happened* in addition to, and to show, what *can happen*.

The same applies to the *heart attack* case; being aware of a worker's condition, fatigue or another cause of poor behaviour, can, in the extreme, save a life. In the novel [2], the project manager notices his enthusiastic staff are working longish hours and through weekends, so in a Friday he ordered them: *Go home early*! And *...do not come in this weekend!* Unfortunately, the instrument engineer substituted weekend strenuous exercise for being at work and that contributed to his end. Equally unfortunately, in the real world although the engineering manager did notice the foreman was working hard, including Saturdays, he did not tell him to ease up.

The question noted above: *How do we impress that on students?* is extremely difficult to answer. Observations of students' responses to accident case studies some years ago, and the recent presentation of a seminar on risk to a class of senior students, suggests engineering students are more interested in technical items than in the people using them. Kletz's writings should be proscribed reading for engineering students (for example) [9].

## CONCLUSION

Before venturing into conclusions one should question: can one draw any conclusions from the actual and fictional incidents described above? Perhaps they are only statistical anomalies? Maybe they are *once in a blue moon* events? Can they be disregarded? That is not so, though they do happen relatively rarely they are typical of what can and does happen in work-life and, therefore, should be recognised as warnings of what *can* happen.

Engineers learn materials, components made from them, can fail, and one learns to overcome that by design, by different shapes, different materials. With operating systems, one listens to the machines, if they rumble or creak or observed data indicates something is wrong one shuts down or does whatever should be done. That is how experienced engineers react to operating systems; however, there is little in the formal education system about what can go wrong with the machines one builds and operates; hence there should be, in the education stream, some teaching about failures of technology.

In a similar vein, one rarely considers that people can fail, too, because the symptoms are more difficult to interpret. The possibility of human failure must be recognised, and appropriate action taken to prevent catastrophic failure of any type. There is also considerable difficulty in including that in student engineers' formal education; it argues against the *engineering mentality*, which is generally geared to *things* rather than *people* - after all, why did the student enter engineering?

Finally, a conclusion about the fictional versions of these incidents, with the dramatic touches added to the actual events, judging by the comments made by engineers and others who read the pre-publication copies, these made more impression than reports in the press or on television, from which one may conclude that telling a story to make a point can carry more weight than delivering the bare facts. Let there be more.

## REFERENCES


1. Ward, R.B., A dangerous, deadly, profession. *Global J. of Engng. Educ*., 14, **3**, 245-249 (2012).
2. Ward, R.B., *A Project in Ammonia*. Melbourne, Australia: Sid Harta Pty. Ltd. (2012).
3. Reason, J., *Human Error*. Cambridge, England: Cambridge University Press (1990).
4. Reason, J., Resident pathogens and risk management. *Safety in Australia*, 9, **3**, May/June (1991). Presented at the World Bank Workshop on Safety Control and Risk Management, Washington, D.C., 18-20 October (1988).
5. Rasmussen, J., Coping safely with complex systems. Invited paper for annual meeting, American Association for Advancement of Science, Boston, 11-15 February (1988).
6. Rasmussen, J., Duncan, K. and Leplat, J. (Eds). *New Technology and Human Error.* Chichester, England: John Wiley and Sons (1987).
7. La Porte, T.R., *On the Design and Management of Nearly Error-Free Organisational Control Systems*. In: Sills, D.L., Wolf, C.P. and Shelanski, V.B. (Eds.), The Accident at Three Mile Island: The Human Dimensions, Westview Press (1982).
8. Ward, R.B., Human error among managers: results of an experiment into *errors of omission*. In: Melchers, R.E. and Stewart, M.G. (Eds), *Proc. Integrated Risk Assessment, Current Practice and New Directions Conf.*, published Rotterdam: Balkema. Newcastle, NSW, June (1995).
9. Kletz, T., *What Went Wrong?* (5th Edn), Burlington, MA: Gulf Professional Publishing (Elsevier) (2009).


## BIOGRAPHY

Ronald Bentley Ward arrived in Sydney, New South Wales, on 6th October, 1928. He attended early schools in inner suburbs, then, Sydney Technical High School, still recognised as the one for engineers and scientists, which was in the 1940s located close to the city, now in a southern suburb. After passing the Leaving Certificate in 1945, he worked as an apprentice, then, as a tradesman toolmaker at the Commonwealth Aircraft Corporation from 1946 to 1954. He, then, moved from aircraft engine manufacture to chemicals and worked with several firms in engineering positions up to 1979 when he opened his own consulting firm, specialising in project management. In 1984, he became a lecturer at the New South Wales Institute of Technology, which became the University of Technology, Sydney, and retired from that position in 2001. While working in industry, he completed a trades course in fitting and machining, the Associateship Diploma (Mechanical Engineering) of the Sydney Technical College, Bachelor of Engineering at the University of New South Wales, and Master of Business Administration at Macquarie University. During the years at the University of Technology he returned to the University of New South Wales to research a thesis on the relationship between hazards and management practices in the chemical industry and was awarded the degree of Doctor of Philosophy in 1995. He has published three books, one text on communication, another on engineering management and a third book outlining some engineering oddities, plus well over a hundred-and-forty papers on education, engineering, accidents, management and speculative topics, over a hundred-and-twenty expert witness reports. He has also written a series of one hundred-and-ten fictional case studies and two as-yet-unpublished novels. All of these exemplify his interest in engineering as a profession and the need of a broad education at the undergraduate level, where topics other than those purely technological should be included and presented in a manner to suit those students. He has lived in Sydney suburbs all his life, and travelled interstate and overseas many times to conferences with his wife, Brenda. He has maintained his connection with engineering education by continuing to write and publish, and by having been accepted in 1998 as a Visiting Fellow in the Faculty of Engineering of the University of New South Wales. He thanks WIETE for the invitation to submit this article for the Global Journal of Engineering Education.