FULL OF HOLES

Why the leaky building problem won't go away

A forensic engineer has drawn parallels between the failures leading to the Erebus disaster and those leading to the Leaky Building crisis. Now, in this paper delivered to the Institute of Professional Engineers, ANDREW MCGREGOR argues that Leaky Building Syndrome could be haunting the property market for years to come

When the Erebus tragedy happened in November 1979, investigators ultimately found a number of reasons, acting in unison, that culminated in the crash. Their conclusions, as previously referred to in *Investigate* last year, have had worldwide significance.

If the lessons from Erebus may have prevented Chernobyl and Bhopal, thenthey could have also prevented today's Leaky Building Syndrome. However, although we may not have fully grasped all the lessons from Erebus, accident causation thinkers such as Gordon Vette and James Reason did.

About ten years after Erebus, Professor James Reason documented his theories on error by referring to organisational deficiencies, latent and active errors (Reason, 1990). Latent failures are often caused by people such as decision makers, managers and regulators well before an accident but with consequences that may lie dormant for some time until active failures or other events trigger them. Active failures are errors and violations with immediate adverse effects that often have close links with individuals or the last stages of the accident timeline and which often attract the interest of legal and insurance processes.

In 1997 Reason published his book titled "Managing the Risks of Organisational Accidents" and included both Captain Vette and another causation thinker, Captain Meurino in his short list of dedications at the front of his book. (Captain Meurino worked for ICAO and was responsible for writing the Human Factors digest No 10.) The book includes what is now referred to as the "Swiss Cheese" accident model. This model portrays the accident timeline as an arrow that penetrates successive defences until an accident occurs. These defence deficiencies are compared to the holes in several layers of Swiss Cheese which all must line up coincidentally for an accident to occur.

This model represents all 'holes' or causes of equal importance and unlike legal and insurance processes, the front holes at the 'blunt' end (latent failures) are as significant as the holes closest to the accident or at the 'sharp' end (active failures).

Under this model there is no single primary cause. The latent failures are as important as the active failures.

Recently Dekker (2002) proposed an alternative model of organisational accidents that is based on failure drift. Although he acknowledges with thanks the work of Reason, he criticises the Swiss Cheese model because it does not explain what the holes consist of or why they line up to let a failure become an accident (Dekker, 2002). He maintains that without the benefit of hindsight, error is hard to define and seeing the holes is difficult and therefore the Swiss Cheese model is not necessarily helpful in accident prevention (remember the Flight TE 901 pilots could not see that they could not see Mt Erebus). Therefore to try and understand why an accident occurs, it is

necessary to reconstruct the unfolding mindset of the organisation and individuals concerned *without the benefit of hindsight*. This is the perspective from which Dekker has developed his 'Drift into Failure' model and his new view of human error.

Dekker's 'Drift into Failure' model consists of three points:

1. People involved in accidents are not criminals or immoral deviants: "Failure drift and accidents that follow them are associated with normal people doing normal work in normal organizations" (Dekker, 2005, p. 24)

2. Often work involves deciding between conflicting goals: Organisations that involve critical safety work are essentially trying to reconcile irreconcilable goals (staying safe and staying in business) (Dekker, 2005)

3. Drifting into failure is incremental. "Accidents don't happen suddenly, nor are they preceded by monumentally bad decisions or bizarrely huge steps away from the ruling norm" (Dekker, 2005, p. 24).

Under this model "the potential of having an accident grows as a normal by-product of resource scarcity and competition" (Dekker, 2005, p. 24).

With the benefit of Reason's and Dekker's models [see the full version of this paper online at www.thebriefingroom.com], it is helpful to review the investigative work of Mahon and Vette. Mahon's ten factors fits Reason's Swiss Cheese model well and the poor communication that existed within Air New Zealand between management and pilots was a significant latent failure at the blunt end of the accident timeline. Although Vette and Mahon painstakingly reconstructed the unfolding mindset of the pilots and determined clearly how the pilot's decisions made sense to them at the time, it was not possible to conduct a similar assessment with Air New Zealand management, who in a blameful context could have been defending their livelihood and the company's right to an insurance payout.

Had Mahon been able to achieve this he might have uncovered industry related problems, such as the poor communication that often exists between many captains and their co-pilots and the fact that civilian trainee pilots do not need to demonstrate comprehensively their skills in bad weather flying. Moreover, he may have discovered that previous whiteout air accidents had occurred before Erebus and that the reports of these accidents were not easy to obtain, as is the case for many air accident reports, even now. In the context of Dekker's new view of human error, the answers to questions such as these may have provided credible reasons for the actions of Air New Zealand management and shown them in a more reputable light than even the Court of Appeal and the Privy Council were able to. At least the Erebus accident organisational accident was investigated comprehensively. Many, such as the Leaky Building Syndrome, are not.

The Leaky Building Syndrome (LBS) arose in the late 90s after the requirement to treat framing timber with Boron biocide was relaxed. LBS is caused by moisture making inroads through a building's external membrane and into its timber framing to the extent that favours fungal activity. This, in turn, leads to decay of the timber andhealth risks for the building users. The final cost to the industry is difficult to estimate but has been estimated by one industry authority to be in the order of 10 billion dollars.

Contrary to common knowledge, this is not the first time that the country has experienced 'leaky building' problems. There is a concern that this problem has not been properly investigated and the controls that have been put in place may not be necessarily appropriate or effective and another 'Leaky Building' type of problem could recur in the future.

LBS is not just caused by the relaxation of timber treatment alone. It is contributed to by the absence of eaves, cracking of plaster clad houses at the joints and walls that incorporated no free drainage cavity between the cladding and the supporting framework.

In order to understand how and why New Zealand became exposed to LBS after 1996, it is helpful to examine a brief history of LBS in New Zealand over the last century.

Around the turn of the 19th century, villas were built relatively high off the ground.

During the 1920s, they were lowered to suit the Californian bungalow appearance but unfortunately to the extent that under floor ventilation was compromised. This increased the moisture content in the sub floor space which in turn led to borer decay and wood rot. The problem was solved by improving under floor ventilation and ensuring that sub floor timbers were durable. However a large number of homes had already deteriorated extensively and the government took ownership of these homes during the depression.

During the 1920s-1930s, the supply of native timbers began to deplete, forcing the building industry to consider the use of inferior timbers such as Radiata Pine.

In 1939, various parties with an interest in building including the State Advances Corporation, commissioned the Department of Scientific and Industrial Research (DSIR) to investigate various options for the treatment of Radiata Pine against both wood rot and insect attack. Radiata timber framing began to be treated with Boron during the 1950s.

After the war and during the 1950s, stucco plaster claddings became relatively popular in the context of material shortages, limited choice and the Art Deco style which came into vogue after the 1931 Napier earthquake. However many houses with these claddings leaked at cladding joints and those without eaves leaked themost. Because of the poor weather-tight performance of plaster claddings, architecture trends changed to brick and tile buildings, which were comparatively more weather-tight due to the relatively wide eaves and the clear drainage space between the brick and the structural frame.

In 1957, a QUANGO called the Timber Preservation Authority (TPA) was formed to regulate and control the treatment of timber. During the mid 1980s, the TPA approved an alternative form of timber preservative for decking that was based on ammonia. This failed and resulted in hundreds of rotting decks which attracted compensation claims that the government paid out. In the context of increasing deregulation the TPA was disbanded in 1987 limiting any future government liability.

However Industry recognized the need for some form of body such as the TPA and replaced it with a voluntary body called the Timber Preservation Council (TPC) which was an advisory body only that lacked the teeth of the TPA.

During the oil crisis of the 70s, building insulation was inserted into the walls of buildings to conserve energy. However this reduced the drainage and ventilation effectiveness of the wall cavity. The need for wall ventilation was removed from NZS 3602 in 1990 but the requirement for sub floor ventilation remained.

During the mid 80s in a political context of increasing deregulation, funding to the NZ Standards Association was significantly reduced. To this day company representatives and consultants contribute to the formulation of new standards on a voluntary basis, without even their disbursements being reimbursed.

At a similar time, several New Zealand commercial buildings suffered weathertightness problems around aluminium curtain wall joinery. In response to this, the window framing industry and the Australian equivalent of the DSIR, CSIRO developed the Sirowet test (Australian Standard AS 4284).

Also during the mid to late 1980s, polystyrene based claddings were introduced followed by the re-introduction of stucco and the development of fibre cement options.

In 1990, the Building Industry Commission (BIC), reporting to the Department of Internal Affairs published a report titled "Reform of Building Controls" which "recommended the introduction of a performance-oriented scheme to replace the existing regulatory scheme which the Commission saw as overly prescriptive and stifling of innovation" (*Sacramento*, 2005, para. 7). The report believed that "a combination of light-handed regulation and the mechanisms of the market would produce better outcomes than the existing scheme" (*Sacramento*, 2005, para. 7) A new Building Act was commissioned in 1991 and this was largely an implementation of the 1990 BIC report. The Building Industry Authority (BIA) was set up to monitor the building control system established by the 1991 Act, with involvement in promulgating the building code, accrediting building products and processes and approving building certifiers.

During the early 90's, higher quality internal finishes were sought which required the kiln drying of timber framing to reduce timber moisture from a maximum of 24% down to 16%. Unfortunately kiln drying results in the evaporation of Boron chemical thus increasing the cost of boron treatment. This was the main reason why Boron treatment was reduced in 1993 and at the end of 1995 effectively eliminated.

Moreover, with such a low moisture content made possible with kiln drying, the risk due to borer attack and wood rot was considered negligible.

In August 1995, NZS 3602 (1995) was revised and one of its changes permitted the deletion of timber treatment provided the moisture content could be maintained to 18% or lower. Interestingly, around this time the New Zealand Standards Association introduced a new standard titled AS/NZS 4360:(1995) Risk Management, which referred to several risk monitoring provisions.

For unknown reasons, the New Zealand Standards Association did not appear to incorporate the provisions of

AS/NZS 4360 when deleting the requirement to treat timber framing with Boron. Had the process laid out in AS/NZS 4360 been implemented after Boron treatment was deleted, much of the widespread damage resulting from the 'Leaky Building Syndrome' could have been prevented.

One example of a large apartment complex that has suffered from LBS is the Sacramento Apartment complex in the suburb of Botany, Auckland. At the time of writing the Sacramento Body Corporate was seeking damages from a large number of defendants including the BIA. In December 2005, the Court of Appeal (CA) struck out the ability for the body corporate of the Sacramento apartment complex to sue the BIA for damages caused by the LBS. Even though the CA conceded several shortcomings of the BIA, it held that the BIA did not have a duty of care to the body corporate holders because of the BIA's lack of legal proximity to the body corporate members. Moreover, its resources allowed under the 1991 Act would not have been sufficient to undertake the extensive monitoring needed to prevent LBS. Also, because the BIA is a quasi-judicial body, it is protected by judicial immunity.

Regrettably, an effective risk managing strategy which the Standards Association itself promulgated in the form of AS/NZS 4360:1995 does not appear to have been implemented. The relaxation of Boron treatment was allowed without a compensating increase in monitoring and inspection requirements and without the institutional memory of the Leaky Building lessons learnt during the last century.

Without comprehensively analysing the latent causes of the Leaky Building Syndrome, a collection of new legal controls have been implemented supposedly to prevent a recurrence. The implementation of these new laws perhaps shields the establishment from blame because it suggests that the cause was due to the negligence of industry practitioners, not defective design standards and controls which the industry looks to for guidance and which the BIA could have supplied, had the government provided it resources to do so. However this new web of laws may unnecessarily complicate future building processes and increase the cost of new buildings, which both the IPENZ book on Risk (IPENZ, 1983) and the 1991 Building Act tried to minimise. The new web of laws may also make it more difficult to attribute the cause of industry problems to defective standards or industry engineering controls in the future if warranted, and therefore the risk of problems such as the 'Leaky Building Syndrome' could recur.

Although it has not been possible in this paper to analyse the Leaky Building Syndrome comprehensively, this discussion at least summarises the areas of interest that a full investigation might address. Of particular concern is that NZS 3602 relaxed the requirement to treat framing timber without the monitoring provisions of the Risk Management Standard, AS/NZS 4360.

CONCLUSION

The Erebus crash has shown the difficulties faced in investigating large organisational accidents and reflected the paradigm shift in thinking from an individual causation model to a more holistic and organisational view, a shift which the world is still learning about. It provided an example of how multiple causes can conspire to generate an accident with contributing factors totally invisible to the participants at the time. It fits both Reason's Swiss Cheese and Dekker's Failure Drift models.

Although the discussion on the Leaky Building Syndrome is not a comprehensive analysis on the leaky building problem, it nonetheless raises questions about the formulation and ongoing maintenance of standards in general.

This study has shown the limited effectiveness of legal processes to determine the latent causes of organisational accidents, and the risk of future recurrences if their causal factors are not comprehensively determined and understood.

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