Managing the Risk of Major Accidents – Lessons from Anglo American's Grosvenor mine accident

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Introduction

Five miners suffered horrendous burns in Anglo American's Grosvenor coal mine explosion in Queensland in 2020. They survived, just, but their lives were forever changed. This paper was prepared at the suggestion of the regulator, Resources Safety and Health, Queensland (RSHQ), to ensure that the lessons of this disaster are not forgotten. It is based on my book, *Sacrificing Safety: Lessons for Chief Executives.*[1] The Grosvenor disaster is relevant to all major hazard industries, in particular, all the industries regulated by RSHQ. In order emphasise this broad relevance, the paper will at many points draw comparisons with BP's oil well blowout on the Deepwater Horizon drilling rig in the Gulf of Mexico[2] . The lessons are essentially of a non-technical nature and concern the way in which companies need to manage the risk of major accidents. The target audience is senior management, both at the corporate head office, and at the business unit levels. The paper will also identify lessons for regulators at various points. Finally, questions are included at the end of each section to encourage readers to think about the relevance of these ideas in their own context.

1 The safety paradox

Senior management at Anglo believed that safety was never sacrificed to production. Their view was safety and productivity went hand in hand and that safety was "just not negotiable". And yet the Board of Inquiry into the accident found that Grosvenor was producing coal at a rate that consistently exceeded the capacity of the drainage system to cope with the methane gas being released, with the result that "coal mine workers were repeatedly subject to an unacceptable level of risk"[3]. How could senior managers believe that they were so safety conscious and yet be so blind to the most serious hazard facing underground coal miners?

The same paradox was evident on the Deepwater Horizon. Coincidentally, at the time of the blowout, senior managers were on the rig, in part to congratulate the crew on its safety performance - seven years without a lost time injury. Yet the most serious hazard confronting a drilling rig - blowout – had somehow slipped below the radar and was being largely ignored, with devastating consequences.

How are we to account for this paradox? The key is to distinguish between, on one hand, hazards that can cause numerous fatalities as well as having a significant financial impact on the whole corporation - major accident hazards - and on the other hand, hazards that generally cause injuries to single individuals, sometimes fatal injuries. In process industries such as oil and gas, the term process safety is often used when talking about major accident hazards, and the distinction is made between process and personal safety. But in the present context, the term process safety can create confusion, so I avoid it here, although I adopt the term personal safety, for want of a better term.

This distinction helps resolve the paradox. It is true that senior managers at Anglo and in the BP Deepwater Horizon case were focussed on safety, but a restricted category of safety - personal safety. Safety with respect to major accident risk lay beyond their field of vision.

One reason for this is that there is an easy-to-understand indicator of how well personal safety is being managed – injury rate. Furthermore, this indicator is context-free, meaning that it can be used across a variety of industries and hazards.[4] It is therefore widely used for corporate reporting. However, injury rate tells us nothing about how well major accident risks are being managed. And unfortunately, there is no single indicator of major hazard safety that can be used across industries and hazards.

The result is that companies operating in hazardous industries have a measure of how well they are managing personal safety but often no measure of how well they are managing major accident risk. In conjunction with bonus systems that place overwhelming emphasis on production, of which more shortly, this means that major accident risks tend to be overlooked.

Question: Are the efforts of your safety specialists primarily focussed on personal injury or is there an equal focus on major hazard risk?

2 Developing indicators for major accident risk

Major accidents are relatively rare, certainly far less common that personal injury accidents. It is therefore not sensible for companies to talk about their major accident rate and set about driving it down, as can be done with personal injury rates. However, the *precursors* to major accidents are more common. In the petrochemical industries hazardous materials such as flammable gases need to be safely contained in pipes or tanks. A loss of containment, by means of leak, rupture, or overflow, is an occasion of heightened risk. Not every loss of containment leads to a major accident event, but every major accident event in these industries is preceded by such a loss. A loss of containment can therefore be thought of as a precursor event. Where the number of such events is significantly more than zero, it can be used to monitor changes in risk level over time and companies can set about driving the number downwards.

An important feature of precursors is that the connection between such an event and the major accident to which it might give rise is normally intuitively obvious. This is not true of many other so called lead indicators, such as audit performance scores, or number of "visible felt leadership" engagements (leaders going into the field to talk to workers)[5]. The link between such indicators and a major unwanted event may be very tenuous. Indeed, there may be no link at all between felt leadership engagements and the adequacy of catastrophic risk management. In the case of the blowout in the Gulf of Mexico, senior leaders were on the drilling rig, on a felt leadership engagement at the very time that drillers were making the series of disastrous decisions that culminated in the blowout. In contrast, there is an obvious connection between precursor events and the events to which they can give rise, making it easier for an organisation to develop and maintain the necessary focus.

We can put this another way: precursor events are warning signs. They are warnings that risks are not under control to the necessary degree. They do not in themselves indicate *what* needs to be done – only that *something* needs to be done. *Wha*t needs to be done matter for management to decide. But provided the number of precursor events materially affects executive bonuses, we can expect that companies will quickly determine the most effective way to drive the risk downwards[6].

Some years ago, under the leadership of the American Petroleum Institute, the petrochemical industries began treating the number of losses of containment as an indicator of major accident risk. The figures were made public in annual reports and companies began giving as much attention to this indicator as they did to injury rates. This was a major advance in management of process safety.

BP was one of the petroleum companies that turned its attention to minimising losses of containment. But this new indicator failed to focus any attention on major accident risk in its drilling operations, culminating in the Gulf of Mexico blowout. Let us see why. The problem is that losses of containment from pipes and tanks were not precursors to the most significant major accident in drilling operations – a blowout. There are other much more relevant precursors, such as "kicks" - where drillers temporarily lose control and oil and gas begins to make its way up the well bore towards the surface. If such a kick is not quickly controlled, it can blow out at the surface. That is what happened on the Deepwater Horizon. In this context, the frequency of kicks, not the frequency of losses of containment, is the best indicator of major accident risk. The lesson here is that the indicators of major accident risk need to be hazard-specific. They cannot be industry-wide but must be based on the worst things that can go wrong in the particular context.

Turning now to underground coal mining, one of the worst imaginable accidents is a methane gas explosion[7] Where the concentration of methane lies between 5% and 15%, the atmosphere is explosive and can ignite, if an ignition source is present. To minimise the danger to miners, legislation requires they retreat to a safe place whenever the concentration of methane reaches or exceeds 2.5%. Such events are called exceedances[8]. The frequency of exceedances is thus a potential measure of how well the risk of methane gas explosion is being controlled.

The legislation specifies that exceedances are high potential incidents (HPIs), and such incidents must be investigated and reported to the inspectorate. But for its own purposes, Anglo American did not regard exceedances as high potential incidents. For the Anglo corporation, as a whole, an HPI was defined as an event that had the potential to cause a permanent injury, a fatality, or worse. Anglo argued that gas exceedances did not have the potential to cause an explosion, if other controls were place, which could reasonably be assumed if there had in fact been no explosion – a curiously circular argument[9]. Nor did an exceedance by itself have the potential to cause permanent injury or fatality. Hence exceedances were not HPIs for internal reporting purposes. Had they been, each such HPI would have been reported to the CEO of Anglo's Australian business unit and to his superior in the corporate centre. But since they were not HPIs in Anglo's system, the company's Australian CEO was not routinely notified of their occurrence. In summary, the company distinguished between "Anglo HPIs" and "Departmental HPIs": the former were taken seriously and contributed to the company's safety statistics; the latter were merely the result of regulatory requirements and could safely be ignored by senior management.

Anglo's approach to exceedances meant that this critical indicator of major accident risk was not recognised as such. In fact the frequency of exceedances at Grosvenor mine was well above other mines in Queensland and should have rung loud alarm bells. But neither the company nor the inspectorate paid adequate attention to this indicator[10]. One option open to the inspectorate would have been to stop production for long enough to ensure critical controls were effective, before allowing mining to recommence. The accident would then almost certainly not have happened.

Before leaving this topic, it is worth mentioning the preeminent example of the precursor event strategy, which can be found in air traffic control organisations (ATCs)[11]. The most dreaded unwanted event for ATC is a mid-air collision. Accordingly, ATC specifies the separation between aircraft that must be maintained. The failure to maintain the specified separation is called a *breakdown of separation*. It is a precursor to a collision. A breakdown of separation does not mean that aircraft are dangerously close; simply that they are closer than they should be, that one or more controls has failed, and that, although the risk of collision may still be extremely low, it has increased. ATC therefore treats the number of breakdowns of separation as an indicator to be closely monitored. Any increase in the number is treated as a matter of great concern. All industries seeking protect themselves from rare but catastrophic events should take this example to heart.

Question. What precursor events can you identify in your operations that could serve as indicators of how well you are managing your major accident risks?

3 Challenging the green and embracing the red

A necessary step towards developing a focus on major accident risk is to change the attitude of top management. Rather than accepting assurances that major accident risks are under control, they need to develop a sceptical attitude. Otherwise, they may be lulled into a false sense of security, which can be literally disastrous. Top management should question the evidence on which the good news in based and seek out bad news that may not be reaching them – "challenge the green and embrace the red".[12] Being sceptical means trying to find out for oneself what is really happening, for example by asking front line workers and technicians in as unthreatening way as possible – "humble inquiry". [13]

Question: In relation to major accident risk, how could you personally implement the idea of challenging the green and embracing the red?

4 The role of incentive payments

The issue of bonus payments has been alluded to above. It is not a secondary issue. It is absolutely central to understanding why major accidents occur.

The raison d'etre of a business corporation is to make money for its owners. Anglo American had what it called a "burning ambition" to double its cash flow between the beginning of 2020 and 2023[14]. This was translated into targets, or production outlooks for its constituent businesses. These targets were announced to investors. Such announcements, often described as market guidance, are accompanied by cautionary statements that the figures are estimates only of what will be produced and that investors should not place "undue reliance" on them. But despite these disclaimers, there is a strong tendency for all concerned to treat them as targets which the company should strive to meet. Where companies fail to meet these targets, they feel obliged to explain to investors why they have fallen short. In this way, market guidance becomes a powerful source of production pressure which can lead ultimately to disaster[15].

Grosvenor's role in helping Anglo to meet its "burning ambition" was to increase production by 50% by 2022[16]. This meant, among other things, that the coal cutting machinery would need to work faster and for longer hours[17].

Annual mine tonnage targets are translated into monthly targets more meaningful to mine workers, namely, number of metres by which a mine face advances (or retreats, depending on the kind of mining). These targets are set, taking account of the geological conditions likely to be encountered. Production bonuses for mine workers are closely tied to reaching targets by a certain date. Reaching the target in the required time yields a certain level of bonus; reaching the target before the target date yields a substantially higher bonus; reaching the target after the date yields a slightly lower bonus. This is a system cleverly designed to maximise the incentives for miners to produce coal as quickly as possible.[18] Safety did not enter into this bonus scheme for mine workers.

Mine managers at Grosvenor were eligible for annual bonuses, explicitly designed to "support our burning ambition"[19]. 82% of this bonus depended on business performance. Managers were therefore under the same pressure to meet and exceed targets as the workforce. Safety was a component in the remaining 18 percent of managers' bonuses, but this was based on personal safety, not the management of major accident risk.

There was therefore nothing in the bonus system to focus attention on major accident risk - nothing to moderate the all-pervasive and overwhelming pressures to cut coal as fast as possible. These were the circumstances in which led Grosvenor produce coal at a rate faster than the methane drainage system could cope with, leading ultimately to disaster.

The situation was similar for drilling operations in the Gulf of Mexico. BP applied constant pressure to drill as quickly as possible. The most important metric for drilling performance was number of days to drill 10,000 feet. This was used for purposes of bonus calculations. There were also targets and schedules, and the well was 38 days behind schedule at the time of the blowout. Being so far behind had put everyone under enormous pressure to finish the job as quickly as possible. Moreover, there was nothing in the bonus system to encourage a focus on blowout risk. It was in this context that drilling managers and engineers took a series of decisions, all of which increased the risk of the blowout that ultimately occurred.

One implication of this discussion is that bonus systems need to be redesigned to focus on major accident risks. Where suitable indicators[20] of major accident risk have been identified, such as frequency of certain precursor events, these can be used, and provided they are given significant weighting, this will help redirect corporate attention.

A rather different strategy is to incentivise the reporting of "bad news" or *warnings* that things are amiss. The essence of high reliability organisations (HROs) is that they are alert to such warning signs. I discuss this in detail in my *Practical Guide to Becoming a High Reliability Organisation* [21].

Question: How could you modify your bonus system to reward the good management of major hazard risk?

5 Managing multiple interacting hazards

The impact of production bonuses on major accident risk is especially problematic where there are complex interacting hazards to be managed. At Grosvenor, managing the methane hazard required both good drainage and also a large ventilation flow to dilute the remaining methane to safe levels. But there was a further hazard to be considered. Loose coal, left to itself, can heat up, in a process known as spontaneous combustion, to a point where it can ignite any explosive mixture of gas that may be present. To prevent such "heatings", loose coal must be starved of oxygen by minimising ventilation flows - precisely the opposite of the strategy needed to manage methane. Technical decision makers must therefore strike a delicate balance in determining the safest ventilation flow, a balance that is inevitably tenuous and subject to revision as new geological circumstances are encountered. Importantly, the only way to achieve this balance may be to slow the rate of production. At Grosvenor, over-riding production pressures undermined all efforts to achieve this delicate balance.

A similar balancing act was required in drilling ultra-deepwater wells in the Gulf of Mexico. Oil and gas reservoirs at great depth are under enormous pressure. Drilling into them can release a flow of oil and gas (a kick), which, if not controlled, may culminate in a blowout. To prevent this, while drilling is underway, the well bore must be filled with a drilling fluid sufficiently heavy to counteract the upwards pressure from the reservoir. On the other hand, if the fluid is too heavy it can crack the rock layers through which the drill is passing and be lost into the surrounding geological formation. Again, a delicate balancing act is required which limits the speed at which the well can be safely drilled. But pressure applied by BP to maximize drilling rate resulted in a variety of kicks and fluid losses. These problems contributed to the delays that BP was experiencing which in turn led to a series of engineering shortcuts that culminated in disaster.

So here is what senior executives in resource companies must understand. The management of complex and interacting hazards is a delicate and uncertain process and may require that limits be placed on the rate of production. The ever-changing geological circumstances, not externally imposed schedules, must be allowed to determine the rate of production. At Grosvenor the perceived need to comply with schedules and budgets drove the mine to the point at which disaster was almost inevitable. Senior executives must find ways to guard against the tyranny of targets.

Question: To what extent do your operations exhibit interacting hazards that require contradictory management strategies that must be delicately balanced?

6 Risk Assessments

The way in which catastrophic risks in hazardous industries should be managed is laid out in a various policies and documents produced by both governments and industry itself. However, Grosvenor paid, at best, lip service to these requirements. It is important to understand some of the ways in which the mine failed to manage its major accident hazards.

The starting point for the management of catastrophic risk is often a regulatory requirement for a risk assessment. But risk assessment means different things to different people. The difference hinges on the meaning of risk. For legislators, regulators, workers and safety professionals, risk means safety risk, while for companies such as Anglo American and for businesses more generally, it means, by and large, financial or commercial risk. This difference in understanding of the term meant that the Grosvenor risk assessments were of little or no value in relation to catastrophic risk, as I show in what follows.

At Grosvenor, the risk of explosion was not even mentioned in risk assessments. In fact, the most serious risk identified was: "gas concentrations prevent operation of face equipment".

This is a risk to production, not safety. This ranked "significant" on a scale of low, medium, significant, high. In this way, the problem of methane concentrations, which for most stakeholders constituted a safety risk, for Anglo American, was transformed into a risk to business objectives. The possibility that an explosion might kill or injure large numbers of people had entirely disappeared from view. Similarly, a risk assessment that BP carried out for drilling in the Gulf of Mexico made no mention of safety and dealt only with the cost and schedule impacts of various scenarios. The potentially catastrophic consequences of a blowout were simply ignored.

Whether these risk assessments are of any use to companies in managing their business risks is doubtful. But they are certainly of no use in managing their catastrophic safety risks. They are meaningless rituals designed to satisfy regulatory requirements. It is remarkable that regulators have apparently not challenged these rituals. Perhaps this would not have mattered if other aspects of the catastrophic risk management system had been working effectively, but they were not, as we shall see.

Question: Do your risk assessments identify and prioritise catastrophic safety risks?

7 Critical controls

Nowadays it is widely accepted that major accident events in hazardous industries can be prevented by identifying suitable control measures and ensuring that those controls are operating as intended. This approach requires, first, that such events be identified. For underground coal mining they would include water inrush, methane gas explosions, coal dust explosions, major fires and major roof falls. For mining more generally, major accidents (also known as major unwanted events) would include high wall collapse in open cut pits, tailings dam collapses, and collisions between heavy and light vehicles, where the latter have multiple occupants. This listing is for illustrative purposes and not intended to be exhaustive. Each site must work out for itself what are its most-feared unwanted events. Once the listing is established, causal pathways to each such event must be identified, in what are called bowtie diagrams, and controls chosen to block each causal pathway Consequences of the event should also be identified and mitigation controls selected (see figure 1[22]). A control is said to be critical if its failure would inevitably increase the risk of a major accident.

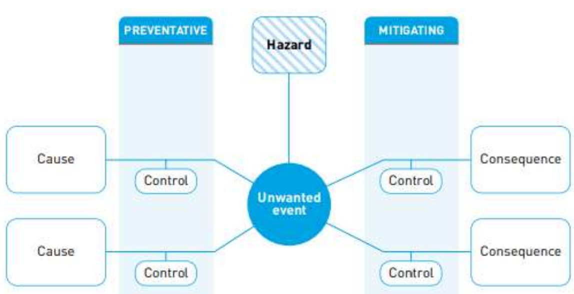

Figure 1
Typical bow tie diagram

An essential additional feature of the method is that performance requirements for controls should be specified and likewise a means of verifying that the controls are performing as intended. If the performance of a proposed control cannot be specified, observed, measured and monitored, it cannot be used as a control. It follows, and needs to be said, that "plans", "management systems" and "policies" are too general to count as controls, although they may contain controls.

The mining industry, and Anglo American in particular, has endorsed the critical control approach to major accident prevention. In 2015, the peak industry body - The International Council for Mining and Metals (ICMM) - produced detailed guidance on the implementation of a system of critical controls[23]. Anglo American is a member of the Council and its own experts participated in the development of the ICMM guidance.

Even before the ICMM guidance was developed, Anglo had implemented a system of critical controls for the management of the methane gas explosion risk at the Grosvenor mine in 2013. This was a requirement of the principal hazard management plan to be discussed below[24]. In short, at the time of the explosion, the use of critical controls for the management of methane gas explosions was theoretically part of Anglo American's safety strategy. In particular, it was operational at Grosvenor mine. Why, then, did this system fail to prevent the accident?

The mine had identified a large number of so-called *priority unwanted events,* of which methane gas explosion was one. It had also identified critical controls for each of these events in spreadsheet format[25]. A number of critical controls for methane gas explosion focussed on eliminating ignition sources. For controlling the gas itself - to prevent the concentration of methane becoming explosive in areas where people might be working - the only control listed was "dilution through ventilation". However, no performance standard was listed for this control, in other words, there was no clear indicator of what would count as a failure. Surprisingly, methane drainage was not even mentioned as a control.

However, a second priority unwanted event on the spreadsheet was "failure of methane drainage system". Several critical controls are specified for this unwanted event, the primary one being "gas drainage design and planning". But, again, there is no performance standard and therefore no clear indicator of what would count as a failure. Moreover, as noted earlier "gas drainage design and planning" is far too general to count as a critical control. Importantly, the failure to link gas drainage explicitly to the prevention of methane gas explosions obscured the significance of this control.

How were these controls to be monitored so as to provide assurance that they were functioning as intended? In the case of ventilation, a control owner carried out a series of audit activities, once a quarter. For gas drainage, the control owner conducted validation and checking activities, once a year. Provided the results of these monitoring activities were satisfactory, the critical controls were assumed to be operating effectively. Unfortunately, there was plenty of other evidence that these controls were *not* operating effectively, specifically large numbers of exceedances, but this was not regarded as relevant. What appears to have happened was that the monitoring of critical controls was treated as routine bureaucratic process and, provided this yielded satisfactory results, nothing else seemed to matter.

The exceedances at Grosvenor provided powerful evidence that vital controls designed to prevent methane gas explosions were not operating effectively. Yet surprisingly, even astonishingly, mine managers failed to draw that conclusion.

In summary, seven years after Anglo American committed to a system of critical controls for Grosvenor mine, and five years after the corporation had committed to such a system company wide, the system was not operating effectively in relation to gas explosion risk at Grosvenor mine.

Question: Are your risk bowties intelligible to all employees, up to and including senior managers? Are the performance standards for the critical controls clearly specified? How do you know when they are failing? What happens when they are found to have failed?

8 Incident investigation

The failure to ensure critical controls were operating effectively was compounded in the *Learning from Incidents* investigations that Anglo did as a matter of course after every exceedance. These investigations often concluded that methane drainage and ventilation were "less than adequate". So frequently was this expression used that it was sometimes abbreviated to "LTA". The logical inference from this was that critical controls had failed to maintain the required level of methane dilution. But this inference was never drawn. The *Learning from Incidents* form explicitly asks for a list of any critical control failures that contributed the event. In the case of these methane exceedance investigations, the explicit answer was "nil" or "not applicable". These answers demonstrate a horrifying level of confusion. On one hand, the analysts identified defects in the ventilation and drainage systems as causes, but on the other, they failed to recognise that this necessarily meant that one or more critical controls had failed. It is important to note, too, that it is not only those who drafted these reports who display this confusion. The reports are signed off by, among others, the head of underground operations, the general manager, the underground mine manager and the HSE manager. Apparently, none of these people was aware of the inherent contradictions in these reports. None of them recognised that the reports in fact pointed to critical control failures that needed to be taken far more seriously than they were.

Incident analyses are of little value, unless senior managers take responsibility for their quality, and furthermore are willing to act on the findings - even findings that require considerable expenditure - so as to prevent similar incidents in the future. That was not the case for Grosvenor exceedance reports.

Question: Do your senior executives take responsibility for the quality of incident reports, and are they committed to acting on the findings?

9 Principal hazard management plans

Many regulatory regimes specify that the management of rare but catastrophic events must start with a clear statement of the catastrophic event of concern, its causes and consequences, and the way in which it is to be prevented. For example, "safety case" regimes require that operators make a "case" to the regulator. This case must identify all possible catastrophic scenarios and demonstrate how these risks will be handled. In the best safety case regimes, the case must be accepted by the regulator, which provides some assurance as to its quality.

A variant of this approach operates in the Queensland resources sector. It is the requirement that operators develop principal hazard management plans. In this alternative approach the regulator itself identifies a minimum list of principal (major) hazards that must be managed, but it is still up to the operator to develop a management plan for each such hazard. In contrast to the best safety case regimes, these plans do not need to be accepted by the regulator. This is one of their weaknesses.

A requirement for principal hazard management plans was enacted for Queensland coal mines after the Moura mine explosion in 1994 that killed eleven men. Accordingly, Grosvenor had a series of these plans, and in particular, one for explosions.

This plan was supposed to be audited internally on an annual basis and externally every three years. It contained an appendix specifying four questions internal auditors must ask. One of these concerns "the elimination of explosive levels of gas". Here is what the auditor is instructed to do.

> Obtain and review the last 12 months of reportable gas limit exceedances to the Mines Department. From a trending perspective, what do the statistics show regarding failure rates and areas of concern? What control strategies have been implemented and are explosive levels of gas being effectively managed?

There were large numbers of exceedances in the years prior to the explosion in 2020, dozens per year. To put this in perspective, for at least one year there were more exceedances at Grosvenor that for all other Queensland coal mines combined. Moreover, the inspectorate and even some mine managers told the Inquiry that a well-designed system of gas drainage and ventilation should ensure no such gas exceedances occurred.[26] The data from the years immediately preceding the explosion are thus a dramatic demonstration that Anglo had failed to ensure "explosive levels of gas [were] being effectively managed". Any person carrying out an internal audit of the principal hazard management plan for explosions should have been alarmed by the statistics and trends revealed.

Evidently, the requirement for a principal hazard management plan failed to prevent this explosion. How could this have happened? There are various possibilities. Perhaps the required audits were not conducted; perhaps they were conducted but auditors failed to sound any alarm; perhaps the auditors did tick the box "non-compliant" or at least "requires improvement" and entered corrective actions in a data base, as required, but these were not acted on; perhaps senior executives were not alerted the findings of such audits. Regardless of the precise reason, the fact is that a legislative innovation designed to prevent major accident events did nothing to stop the headlong rush to disaster, driven by the production imperatives discussed earlier. There are lessons here for companies. They need to develop organisational designs to ensure their principal hazard management plans are working as intended. I shall sketch such a design shortly. There are lessons, too, for regulators. They should ensure that companies have organisational strategies to ensure that these plans are working as intended.

Question: How can you be sure that your principal hazard management plans are not failing in the way that the explosion management plan failed at Grosvenor?

10 Organisational structure[27]

Safety is compromised where technical functions (engineering etc) are decentralised, that is, where working engineers answer to relatively low-level commercial managers and higher level technical managers have no authority at lower levels. There is a need for strong technical functions that can resist commercial pressures.

This was the lesson BP drew from the Deepwater Horizon disaster. Five months after the accident, it made the following announcement:

> BP is to create a new safety division with sweeping powers to oversee and audit the company's operations around the world. The Safety and Operational Risk [S&OR] function will have authority to intervene in all aspects of technical activities. It will have its own expert staff embedded in BP's operating units, including exploration projects and refineries. It will be responsible for ensuring that all operations are carried out to common standards, and for auditing compliance with those standards. [Its head will report directly to BP's chief executive.]

In this statement, operational risk refers to major accident risk. Note also that the staff of this function are not just occasional visitors to the business units - they are embedded in these units, though accountable up the functional line to the head of S&OR. This line of accountability ensures that their judgements are not compromised by the commercial goals of business unit managers they work with.

The same lesson has been learnt by the Boeing aircraft manufacturer after the crash of its two 737 MAX aircraft in 2018 and 2019. Prior to these accidents its engineers were answerable to relatively low-level commercial managers; after the accidents they answered up an engineering line to a chief engineer on Boeing's Executive Leadership Team.

This is also arguably the most fundamental lesson emerging from the Grosvenor accident. Prudent risk management, advice provided by technical experts and sound technical practices were ignored or over-ridden by commercial line managers, in ways the contributed to the accident. Companies like Anglo need to restructure themselves so that the technical people have far greater authority than they currently have. The following two figures show how.

Figure 2 is the organisational structure at the time of the accident It is a highly simplified version of Anglo's organisational chart, designed to show only the relationships of interest in the present discussion. Moreover, it is based on incomplete information[28] and may not be entirely accurate, but it suffices, for present purposes. The main line of accountability is the commercial line, running downwards from the CEO and Board. The technical positions are off to the side and somewhat isolated from each other. They are advisory positions, with no organisational authority of their own.

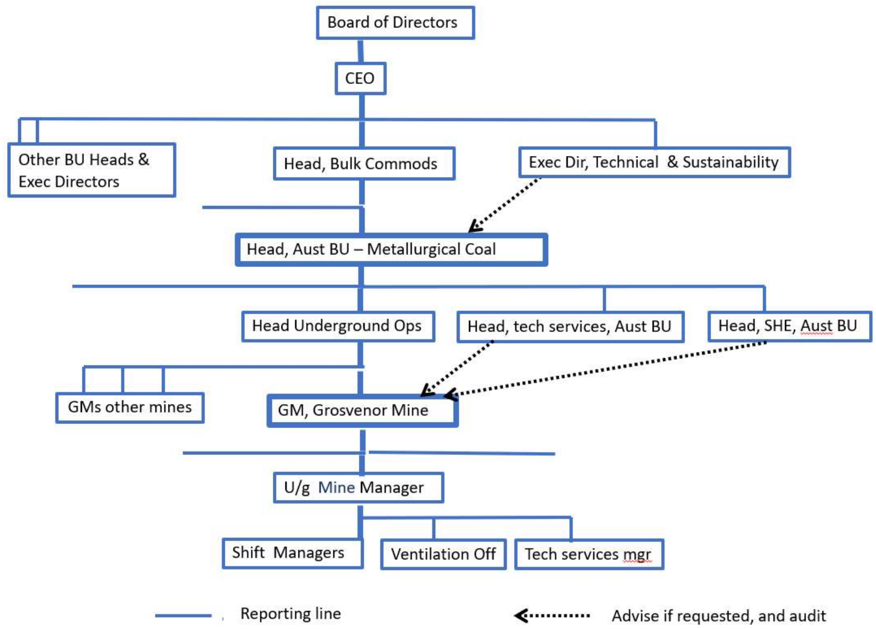

Fig 2 Simplified org chart for Grosvenor at time of explosion showing relationships of interest

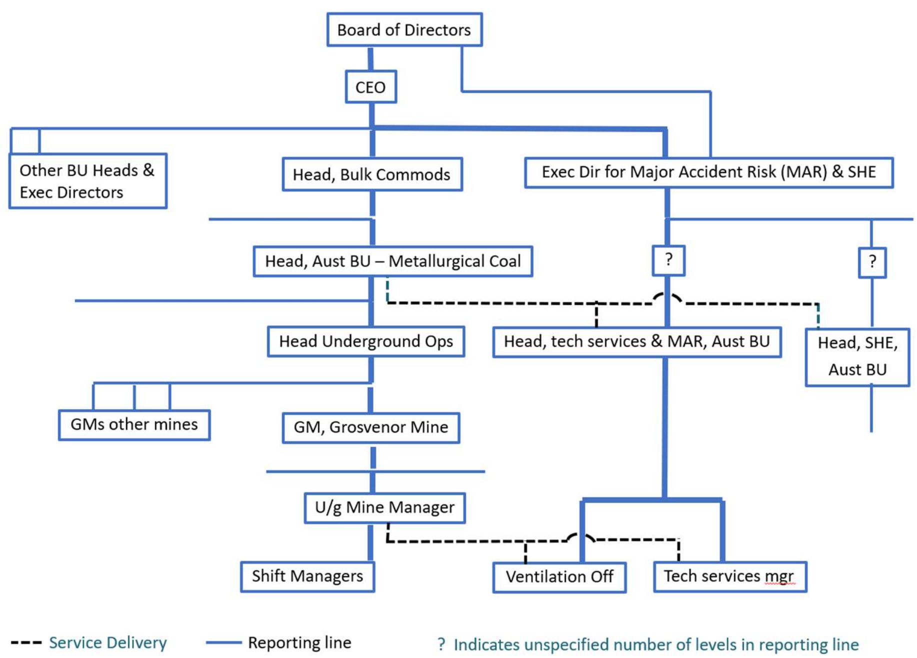

Figure 3 Proposed org. structure for management of catastrophic risk at Grosvenor

In figure 3, all technical positions are organised into a second reporting line. We can describe this as a centralised technical function, because it reports to the corporate centre. People in these positions report to higher level technical people and their bonuses and indeed career prospects depend on how they are evaluated by their supervisors in this line. Realistically these supervisors will solicit input from the commercial managers to whom the services are provided, but it must be the technical supervisors who have the final say. The question then is: how do these two reporting lines relate to each other? The dotted lines represent the relationship. Technical positions *provide services* to the commercial line. They are co-located (embedded) with the business unit, providing services as required by the unit. The dotted lines are drawn in such a way as to suggest that these technical managers sit on the senior leadership team of the relevant business unit leader, along with other line managers. This should provide them with equal ability to influence outcomes when there are differences of opinion. Moreover, if necessary, they are able to escalate matters to their supervisors in the technical line[29]. This is a vital feature of the decision-making process that would have stood in the way of some of the more commercially oriented decisions made at Grosvenor.

Another feature of figure 3 is that major accident risk (MAR) has become more explicit. It is implicit in figure 2 in the term “sustainability”, but in figure 3 sustainability is broken into two parts - MAR and SHE (personal safety, health and environment). These are separated organisationally as one moves down the chart, reflecting the very different skill sets they require.

What these lines have in common is that neither is primarily concerned with the commercial interests of the business unit in which they are embedded, but rather with the sustainability values that most large corporations profess. They are complementary to each other, rather than in tension. This means that an executive director accountable for both does not have trade off one against the other. In contrast, in Anglo’s present organisational structure the heads of business units are accountable for safety in all its forms, and also for profitability. Situations will inevitably arise where there is a conflict between these goals, creating a conflict of interest for these business unit heads, as was demonstrated so clearly at Grosvenor, where safety was sacrificed to production.

It should go without saying, but unfortunately needs to be emphasised, that incentive arrangements of people in these technical lines should be based on their contribution to relevant sustainability goals, and not in any way on the corporation’s commercial success.

The organisational structure depicted in figure 3 focusses on Grosvenor mine. Even in that context it should be regarded as provisional. In other contexts, the details will be different but the principles will be the same. This is the type of organisational structure that is necessary to counteract the commercial pressures that may otherwise compromise the effective management of catastrophic risk.

Question: Is your technical function as influential as it needs to be? What organisational changes might you make to give it greater authority?

11 The role of the regulator

The lessons identified in this paper are largely for senior executive to act on. Regulators need to ensure that senior executives are indeed implementing all these lessons.

Consolidated question list

1. *Question: Are the efforts of your safety specialists primarily focussed on personal injury or is there an equal focus on major hazard risk?*

2. *What precursor events can you identify in your operations that could serve as indicators of how well you are managing your major accident risks?*

3. *In relation to major accident risk, how could you personally implement the idea of challenging the green and embracing the red?*

4. *How could you modify your bonus system to reward the good management of major hazard risk?*

5. *To what extent do your operations exhibit interacting hazards that require contradictory management strategies that must be delicately balanced?*

6. *Do your risk assessments identify and prioritise catastrophic safety risks?*

7. *Are your bowties intelligible to all employees, up to and including senior managers? Are the performance standards for the critical controls clearly specified? How do you know when they are failing? What happens when they are found to have failed?*

8. *Do your senior executives take responsibility for the quality of incident reports, and are they committed to act on the findings?*

9. *How can you be sure that your principal hazard management plans are not failing in the way that the explosion management plan failed at Grosvenor?*

10. *Is your technical function as influential as it needs to be? What organisational changes might you make to give it greater authority?*

Endnotes

[1] (CCH, Sydney, 2022). https://shop.wolterskluwer.com.au
[2] Hopkins A (2012) *Disastrous Decisions: The Human and Organisational Causes of the Gulf of Mexico Blowout* (CCH: Sydney)
[3] Queensland Coal Mining Board of Inquiry, Report Part II, pp. 6, 26
[4] There are various options - LTIFR, TRIFR, Serious Injury Rate, the last being the most reliable.
[5] Anglo's Australian Business Unit used this as an indicator. See T (Transcript of the Board of Inquiry) p708.
[6] See section below on incentive payments
[7] Such events are even worse if they trigger a coal dust explosion.
[8] Power must be cut off automatically to mining machinery if methane concentration in the vicinity reaches 2%. This is called a methane trip.
[9] The argument is examined in more detail in my book, p32
[10] See BoI Report II, p 174, recommendation 5.
[11] Hopkins A, *Learning from High Reliability Organisations*, Sydney, CCH, 2009.
[12] Hopkins, "A Practical Guide to Becoming a High Reliability Organisation" See web address in note 21, below
[13] ibid
[14] This is a slight simplification. See T pp709,710
[15] For a more extensive discussion see Hopkins A & Kemp D, *Credibility Crisis: Brumadinho and the Politics of Mining Industry Reform*. (CCH, Sydney, 2021), pp74-75
[16] T p709, 710.
[17] T pp716-717
[18] Grosvenor One Key Resources Performance Incentive Scheme December – 2019.
[19] Report of BoI Part I, p182
[20] Suitable includes consideration of how susceptible they are to gaming.
[21] See Hopkins, "A Practical Guide to Becoming a High Reliability Organisation" https://www.aihs.org.au/sites/default/files/A%20Practical%20Guide%20to%20becoming%20a%20High%20Reliability%20Organisation%20-%20Andrew%20Hopkins.pdf. See also Peter Wilkinson. "How can HRO improve your safety in mining?" *OHS Professional* March 2022, pp10-13 At the time of writing there is much interest in HROs in the Queensland Resources sector. There is also much confusion
[22] Source: https://www.icmm.com/website/publications/pdfs/health-and-safety/9722.pdf, p22
[23] www.icmm.com/website/publications/pdfs/health-and-safety/9722.pdf
[24] https://coalminesinquiry.qld.gov.au/wp-content/uploads/2020/09/GRO-8-PHMP-Principal-Hazard-Management-Plan-Explosions-Version-Five-02082018.pdf
[25] Strictly, controls should be identified for each cause that could give rise to a priority unwanted event. https://coalminesinquiry.qld.gov.au/wp-content/uploads/2020/12/GRO-96367-REG-Grosvenor-Coal-Mine-Critical-Control-Register.pdf .
[26] Report 1, p35
[27] For a more complete discussion of the issues in this section, *Sacrificing Safety*, chapter 7
[28] See Qld Coal Mining Safety and Health Act 1999, Secs 60(10), 61(2), and Statement of Tyler Mitchelson to inquiry, p14
[29] The detailed organisational structure within a coal mine would need to be adjusted to take account of the principles sketched here. For example, underground coal mines in Queensland employ Explosive Risk Zone Controllers (Deputies), not shown in Figures 2 and 3. Deputies have twin roles. They are both frontline supervisors and technical specialists (in relation to explosive risk control). Their designation as ERZ controller suggest that this is their primary role, in which case they should be primarily answerable to the technical/MAR line. It might be appropriate to divide the functions and appoint another person as supervisor, answerable up the commercial line. It may be objected that these arrangements are impossible under the Qld Coal Mining Safety and Health Act 1999, pp57,58. But if the principles are accepted it should be possible to deal with such objections.