The Role of Information Management in Preventing Major Disasters

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When reflecting upon some of the most notable disasters that have happened world-wide, it is disappointing how often a contributor to the cause of the disaster was poor information management (IM) practices. Managing information effectively is just good business sense. The principles of IM come from two sources. Firstly, Archives New Zealand (2000) says information is to be:

- Complete: includes structural and contextual information, the process that produced it and other linked documents
- Comprehensive: records the whole business process
- Adequate: fit for the purpose for which it is being kept
- Accurate: correctly reflects what was communicated, decided or done
- Authentic: it is what it purports to be
- Useable: identifiable, retrievable, accessible, and available when needed
- Tamper-proof: security maintained to prevent unauthorised access, destruction, alteration or removal

Secondly, IM is about (adapted from Ross, et.al., 1996 and Johansson & Hollnagel, 2007):

- Systems: Computer systems as well as systems such as file classification and security classification
- Business processes: An orderly sequence of tasks. In essence, prompting people to do the right thing at the right time
- People: The people having the skills to do the task and understanding why they are doing it so they do the task willingly.
- Ideally, these three should be well balance. Whenever one of the three is underperforming, the other two have to take up the slack.
- With those IM principles in mind, let's look at some disastrous events.

Pike River (Royal Commission, 2012, Cover).

On 19 November 2010, an explosion occurred at Pike River coal mine taking the lives of 29 men and injuring two survivors.

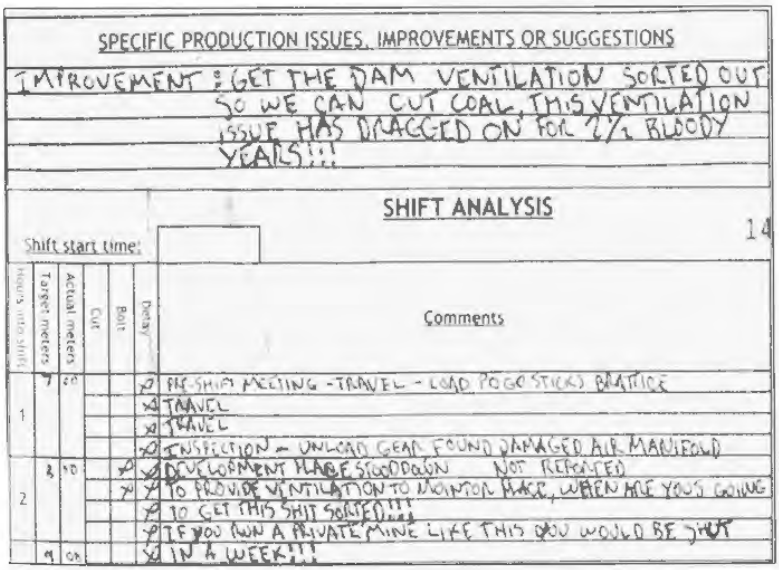
One and a-half hours after the explosion, two men walked out of the mine telling of how they were injured by the explosion and how they passed out as they slowly made their way out (a two kilometre walk) by the air being unbreathable. The explosion had severed all the electrical monitoring equipment connected to the above-ground control room. An electrician was sent into the mine to try to repair the damaged electrical connections but he turned back without going in very far because the air was unbreathable. Several air samples were then taken and these indicated the mine was still on fire. A borehole was drilled into the heart of the mine reaching pit bottom five days after the first explosion. Through that hole, they took air samples bringing hope that the air may be breathable enabling people to enter the mine and perhaps some of the men might still be alive if they had been able to reach some of the "self-rescuer" breathing devices. However, the experts in coal mining and mine rescues saw the CCTV footage of the explosion at the portal and believed no one could have survived the blast. A few hours after taking the air samples at pit bottom, the second explosion occurred dashing all hope of any survivors as it was multiple times worse than the first. There were two further explosions.

Some coal mines emit methane gas from the coal seam. Pike River was one of these. Hydro mining (like water blasting) produces more methane than dynamiting out the coal. If methane is kept diluted with good air ventilation, it is less likely to ignite. However if there isn't good

ventilation and the gas can concentrate, it is easily ignitable. Methane is lighter than air so it rises, leaving the breathable air at floor level and the methane concentration at the ceiling. The equipment that took readings of the air quality showed numerous times throughout October and November when the methane concentration was at dangerous levels. These readings didn't go to the managers nor did they receive publicity. They were not reported in daily production or weekly operations meetings nor through the deputies production reporting system (as demonstrated later). They were not reported to the regulator as the regulation required.

At management level, there were committee meetings which had action sheets that recorded the person responsible for the action and expected completion date. If it was simple, it generally was done. However actions required of some departments were routinely left undone. The actions that required a coordination of several departments were also routinely left undone.

Image 2 is an example of a Deputy production report: this example was completed by Dene Murphy on 21 October 2010, less than a month before the explosion. On average, Mr Murphy put in one of these reports per day for two years. So you can see the frustration he was feeling in the language he used to express himself. This was Pike River's system of



SPECIFIC PRODUCTION ISSUES, IMPROVEMENTS OR SUGGESTIONS

IMPROVEMENT: GET THE DAM VENTILATION SORTED OUT SO WE CAN CUT COAL, THIS VENTILATION ISSUE HAS DRAGGED ON FOR 2½ BLOODY YEARS!!!

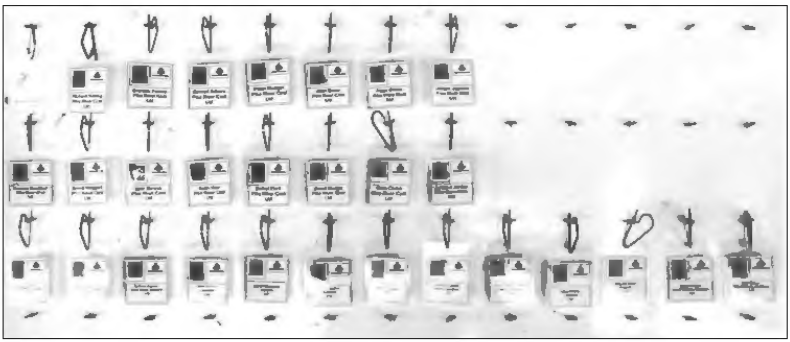
SHIFT ANALYSIS

Shift start time: 14

Hours into shift	Target meters	Actual meters	Cut	Bolt	Delay	Comments
1	7	20			☒	PRE-SHIFT MEETING - TRAVEL - LOAD POGO STICKS) PRACTICE
					☒	TRAVEL
					☒	TRAVEL
					☒	INSPECTION - UNLOAD GEAR FOUND DAMAGED AIR MANIFOLD
2	8	10			☒	DEVELOPMENT FLARE SLOWDOWN NOT REPORTED
					☒	TO PROVIDE VENTILATION TO MONITOR FLARE, WHEN ARE YOUS GOING
					☒	TO GET THIS SHIT SORTED!!!
					☒	IF YOU RUN A PRIVATE MINE LIKE THIS YOU WOULD BE SHUT
	9	30			☒	IN A WEEK!!!

Image 2: Extracts from Dene Murphy's 21 October 2010 deputies production report (Royal Commission, 2012, vol. 2, p. 105).

identifying matters that presented safety risks for the employees. There were also many other reports about incidents, accidents and hazards. However, there was no business process for sorting, classifying, passing the concerns on to a manager who could/would do something about it. Many of these were just thrown away. Those not tossed became a large accumulation. In fact the Royal Commission analysed 1083 of them.



ID tag board (Macfie, 2013, after p. 198)

Amongst the victims of the poor information management were the families of all the mine workers. Pike River's system of identifying who was underground and who wasn't did not receive full compliance. At the time of the explosion, they could not quickly identify who was affected by it. Over the 20 hours it took to ascertain exactly who was underground, the families were distressed.

How could the IM principles outlined at the top have made a difference at Pike River? There was no management information system. Vital information was not brought together, summarised and analysed for executive managers. The key information on health and safety incidents was available but was not handled systematically and therefore did not receive a response. Therefore the information was not *usable* because the *business processes* didn't have it go to the right person who could/would respond to it appropriately. The system for recording who was in the mine at any given moment didn't work. Therefore the information was *inaccurate*. One of the most unforgiveable IM mistakes was the constant false information from senior management of how well things were going while those close to the operations knew things weren't going well at all.

The next tragedy to explore is the capsizing of the *Herald of Free Enterprise* Ferry between Dover and Bruges-Zeebrugge on 8 March 1987 killing 193 people. On that day 650 passengers were on board. The doors to the car deck were left open. Water entered the ship at the car deck and caused it to capsize. The doors being open would not have in itself caused the ship to capsize because a sister ship made the crossing with her doors open without incident.

This ship did not normally do the Dover to Bruges-Zeebrugge run. The pier and the ship's decks didn't match each other. The drawbridge could only go to one deck and vehicles could only be loaded onto that one deck. The ship had to fill its forward ballast tanks to lower the ship in the water to enable cars to use the drawbridge and load onto it. The ship was due to be modified during its next refit scheduled for later that year to overcome this limitation.

Most ships are divided into watertight compartments below the waterline so that in the event of flooding, the water will be confined to one compartment, keeping the ship afloat. However the car deck was open with no dividers.

Normal practice was for an assistant boatswain to close the ferry doors before dropping moorings. Usually the first officer would remain on deck to ensure they were closed before returning to the wheelhouse.

On 8 March, they were running behind time. The captain was under pressure from the owner of the ferry (Townsend Thoresen) to be on time. The ship was designed for quick acceleration. The weather brought calm conditions. Although there was a high spring tide, the water was shallow especially with the ballast.

The First officer returned to the wheelhouse before the ship dropped its moorings (which should not happen but commonly did). He trusted the assistant boatswain to close the doors. However the assistant boatswain went to his cabin and took a nap. The captain presumed the doors were closed. He couldn't see the doors from the wheelhouse. The doors are held by massive hydraulic rams, so they couldn't open by themselves or by water pressure. There was no warning system in the wheelhouse to alert the captain if the door was open. In the hurry to get away without falling further behind time, they also neglected to dump the ballast. The ship was in shallow water and was going too fast. They only got 91 metres from shore.

The ship's captain acted on the inaccurate presumption that the doors were closed and did not have access from the wheelhouse to the information to tell him they were still open. He did not have access to accurate information. The business process broke down in two ways.

Firstly, the process of the boatswain informing the captain broke down as the captain did not get the information about the doors before dropping moorings. Secondly, process for the crew to dump the ballast before dropping moorings broke down. There were also human errors: it doesn't help when a key crew member is asleep in his cabin or when a captain is in such a hurry to keep to the schedule that he neglects to complete the checks before dropping moorings. In this case the checks were closing a door and dumping ballast.

The next disaster to explore is Union Carbide in Bhopal on 2-3 December 1984. Conservative estimates say there were 8,000 fatalities, 10,000 permanent disabilities, and 558,125 injuries. Even now after 30 years, 150,000 survivors are still struggling with serious medical conditions.

This chemical plant produced Methyl isocyanate (MIC), a garden pesticide. Over 2 and 3 December 1984, MIC was released into the air. There are differing versions of what happened so to stay away from the controversial areas, I'll focus on what is in agreement between the various sides. A relatively new worker was assigned to wash out some pipes and filters which were clogged. The pipe-washing operation should have been supervised by the second shift supervisor, but that position had been eliminated in a cost-cutting effort. MIC produces large amounts

Union Carbide, Bhopal (Wikimedia Foundation)

of heat when in contact with water, and the worker properly closed the valves to isolate the MIC tanks from the pipes and filters being washed. However, somehow water entered the MIC tanks causing the explosion. The relief valve opened venting MIC into the air and the wind carried the MIC into the population around the plant.

It is not uncommon for a company to turn off passive safety devices, such as refrigeration units, to save money. The operating manual specified that the refrigeration unit *must* be operating whenever MIC was in the system since the chemical has to be maintained at a temperature no higher than 5˚ celsius to avoid uncontrolled reactions. A high temperature alarm was to sound if the MIC reached 11˚. The refrigeration unit was turned off, however, and the MIC was usually stored at nearly 20˚. The plant management adjusted the threshold of the alarm, accordingly, from 11˚ to 20˚ and tank temperature readings were taken less often, thus eliminating the possibility of an early warning of rising temperatures.

Other protection devices at the plant also had inadequate design thresholds. For example, the vent scrubber (which neutralises MIC with caustic soda) was designed to neutralize only small quantities of gas at fairly low pressures and temperatures. The pressure of the escaping gas during the accident exceeded the scrubber's design by nearly two and a half times. Several gas scrubbers had been out of service for 5 months and only one was operating on the day and the temperature of the escaping gas was at least 80˚ celsius more than the scrubber could handle.

Similarly, the flare tower that was supposed to burn off released vapor was totally inadequate for managing the estimated 40 tons of MIC that escaped during the accident. It could only handle a quarter of the gas that leaked when working but it was out of order at the time of the incident. Any leak could go unnoticed for a long time.

In addition, there was a water curtain spraying water on the gas to knock it down to limit contamination. The MIC was vented from the vent stack 108 feet above the ground, well above the height the water could be sprayed due to inadequate water pressure. The water curtain reached only 40 to 50 feet above the ground. The water jets could reach as high as 115 feet, but only if operated individually.

The water would not have caused the severe explosion had the refrigeration unit not been disconnected and drained of Freon, or had the gauges been properly working and monitored, or had various steps been taken at the first smell of MIC instead of being put off until after the tea break, or had the scrubber been in service, or had the water sprays been designed to go high enough to douse the emissions, or had

the flare tower been working and been of sufficient capacity to handle a large excursion.

A safety audit two years earlier by a team from Union Carbide had noted many safety problems at the plant, including several involved in the accident. The manager said all the identified issues were corrected, however the quality must have been poor as they remained deficient.

Alarms at the plant sounded twenty to thirty times a week for various purposes. An actual alert could not be distinguished from routine events or practice alerts. Ironically, the warning siren was not turned on until two hours after the MIC leak was detected (and after most all the injuries occurred) and then was turned off after only five minutes – which was company policy.

As cost cutting measures, the maintenance and operating personnel were cut in half. Maintenance procedures were severely cut back and the shift relieving system was suspended – if no replacement showed up at the end of the shift, the following shift went unmanned. Staff complained about the cuts through their union but were ignored.

Staff were commanded to deviate from the proper safety regulations. Seventy percent of them were fined for refusing to deviate. "There was widespread belief among employees that the management had taken drastic and imprudent measures to cut costs and that attention to details that ensure safe operation were absent" (Lihou, 1990).

When the danger during the release became known, many employees ran from the contaminated area of the plant, totally ignoring the buses that were sitting idle ready to evacuate workers and nearby residents. Plant workers had only a bare minimum of emergency equipment: a shortage of oxygen masks, for example, was discovered after the accident started. They also had almost no knowledge or training about how to handle nonroutine events.

The surrounding community were not warned of the dangers, before or during the release, or informed of the simple precautions that could have saved them from lethal exposure, such as putting a wet cloth over their face and closing their eyes. If the community had been alerted and provided with this simple information, many (if not most) lives would have been saved and injuries prevented.

As controversy raged over who to blame, Leveson merely indicates it was an accident waiting to happen. "Given the overall state of the Bhopal Union Carbide plant and its operation, if the action of inserting the slip disk had not been left out of the pipe washing operation that December day in 1984, something else would have triggered an accident" (Leveson, 2011, p. 28).

The information was not comprehensive from the time they stopped logging temperatures causing there to be no records of necessary data. Information is not useable when there are multiple alarms going off often: information overload makes the necessary information unidentifiable. The system for providing a warning siren was turned off. Business processes intended to enable information sharing did not function as intended. Firstly, They acted contrary to the operating manual to allow temperatures to rise higher than the manual allowed. Secondly, safety audits documented problems and none of the recommended changes were made. The information didn't reach those who could and would do something. Lastly, there was no process for informing people around the facility on how to simply protect themselves from harm.

The next disaster to explore is Turkish Airlines flight 981 on 3 March 1974 killing 346 people. The cargo doors of DC-10s would come open during flight. The design flaw in the cargo door was first discovered in 1969 and was left uncorrected. In June 1972, Flight 96 near Windsor, Ontario had its cargo door open during flight. The decompression caused the passenger floor to be sucked out and the control cables that run through it were severed. The pilot had trained himself to fly and safely land the plane without the controls, so no disaster occurred. The pilot was also helped by the plane carrying a light load. The pilot recommended that every DC-10 pilot be training in the flying technique that saved him, his passengers, the crew and the aircraft. The FAA investigators, the National Transportation Safety Board, and the engineers all recommended changes in the design to prevent cargo doors opening during flight. However McDonnell Douglas attributed the Windsor incident as "human error on the part of the baggage handler responsible for closing the cargo compartment door". The door could be improperly closed but made to appear by the warning system in the cockpit to be properly closed.

Two years later when Turkish Airlines was flying to Paris loaded down to the max, the same thing happened as what happened in Windsor. Due to the heaviness of the load, the pilot was not able to establish any other control with the cables severed.

Other factors:

- A support plate for the handle linkage of the cargo door had not been installed, although this work had been documented as completed.
- The warning notices around the cargo door were written in Turkish and English. The baggage handler was fluent in three

languages, none of which were Turkish or English.

- The plane had a small indicator window that allowed baggage handlers to visually inspect that the pins were in the correct position. This plane had the window. However, this baggage handler hadn't been trained about the purpose of the window and couldn't read the instructions.
- An investigator found that the pins on the cargo door had been filed down because the baggage handlers had trouble closing the door. After the pins were filed down, they were able to close the door effortlessly. That caused the door to only be able to withstand 15 psi of pressure, whereas it was designed to withstand 300 psi.
- McDonnell-Douglas issued a service bulletin to change the door latch. Three months later, Turkish Airlines ordered this plane. Another three months after that, the plane was delivered. So McDonnell-Douglas didn't fix the problem on the planes in its assembly line.

Again McDonnell Douglas blamed the baggage handler, however this time the FAA "ordered" modifications to all DC-10s to eliminate the hazard.

In this case, the information signalling to the pilot that the door is properly closed was inaccurate. There was also false information about the plate being installed when it was not. The accurate information was inaccessible to the baggage handler by being in languages he did not know. The business process at McDonnell-Douglas was inadequate that it had issued a service bulletin to fix the known problem, but delivered a plane six months later that did not have the "fix" applied.

The next disaster to explore is the Piper Alpha on 6 July 1988 killing 165 people and two people from the rescue team. The Piper Alpha was an oil/gas rig in the north sea off the British coast operated by Occidental Petroleum (Caledonia) Ltd. There were 226 people on the rig.

Two information disasters occurred in this scenario: the causes of the initial explosion and the issues around rescuing the staff off the rig.

This rig had pipeline connections to two other rigs (The Tartan and Claymore) that were a few kilometres away and two pipelines: one to Orkney Islands for crude oil and to the MCP-01 for gas compression. They had a maintenance schedule in which valves were replaced every 24 months. In July 1988, there were quite a few known leaks around the rig. They had shut down a number of pipes and pumps for maintenance. At about 9:45 p.m. about six alarms went off from a wide variety of locations. Safety devices were triggered that shut down functions they

Piper Alpha (Wikimedia Foundation)

were connected to. Although it wasn't unusual for all those functions to be shut down, if they are all shut down at the same time, no power is being generated resulting in a full black-out. With no power, it is much harder to restart, so they wanted to avoid that problem.

Pump A was down for a major overhaul of a pressure safety valve. Not all the "lead operators" (i.e. managers) knew that. Some thought it was only down for routine maintenance. As a "lead operator" went off duty and the next one came on, the status of the valve and therefore the pump wasn't communicated. However it was communicated on the written "permit to work" which said "not ready and must not be switched on under any circumstances".

When Pump B had a triggered shut down and they couldn't restart it, they wanted to get pump A running as soon as possible because the entire power supply of the offshore construction work depended on these pumps. The "lead operator" who authorised Pump A to be started seemed to not know that the valve was in the maintenance repair shop. He saw a "permit to work" that said the pump was to be overhauled (which had not been started) but he didn't find the "permit to work" about the overhauled valve as it was in a different location. The "permits" were sorted by location and not cross-referenced. So Pump A was started without its valve, causing enough condensate (natural gas liquids) to

leak out that would explode as soon as it found a source of ignition.

Over the next few minutes, this first explosion caused a chain of events that led to several other fires and explosions. These include a pool of oil and a pipe for riser bursting. The operator threw the switch to shut down all the pipes and pumps. The fire would have burnt out were it not being fed with oil and gas from the Tartan and Claymore platforms. The managers of those platforms didn't have permission from the Occidental control centre to shut down with the first emergency call.

There were issues with the "Permit to Work" system. As mentioned before, they were not looked at as shifts turned over. Those completing the form did not put enough detail down. They would be filled in with minimal information in a hurry. "There were always times when it was a surprise when you found out some things that were going on" (Clark in Cullen, 1990, vol. 1, pp. 121, 197). The forms were not cross-referenced to get the complete picture of how each is interconnected to the other. So one permit would say Pump A was down for maintenance but would not be connected to the other permit that said the valve was removed from the pump and was in the maintenance repair shop.

Regarding the disaster of the rescue activities, the procedures were that the lead operator was to announce over the loud speakers what to do to evacuate. He failed to do this. When many of the men became aware a state of emergency existed, they did what they were taught in "drills" to do: go up to the helipad and wait for a helicopters to rescue them. However in this case, that wasn't the best thing to do. There were six helicopters flying in the area but they couldn't land on the helipad because there was too much wind, fire, and smoke obscuring visibility. It put those men higher up so that those who jumped into the sea were at greater risk of that impact killing them. "Drills" also taught them to go to lifeboat stations, but the fire prevented that.

As the first explosion occurred at 10 p.m., the night shift was on duty and the rest of the men were either in the TV room, the cinema or in the accommodation block sleeping. The accommodation block was believed to be completely fireproof but it wasn't. With the first explosion, the common exits were unusable due to smoke. Only those who were very familiar with the rig knew of another way out that avoided the smoke and got them down to lower levels. These were low enough that if someone jumped into the sea, they could survive the impact. Many of the men stayed in the accommodation block, waiting for instructions that never came. They believed staying in the accommodation block was the safest place for them. They didn't follow the men who were familiar with the rig. Hours later, the whole accommodation block went into the sea, and

when it was recovered, the post-mortems showed that the occupants died of smoke inhalation not drowning.

"These examples serve to demonstrate that the operating staff had no commitment to working to the written procedure; and that the procedure was knowingly and flagrantly disregarded" (Cullen, 1990, vol. 1, p. 193).

Reflecting on IM principles, the information was incomplete and not comprehensive as the Permit to Work system didn't supply comprehensive or complete information as it was intended to do. The lead operator had the information of what to do in case of an emergency (or should have had it) and did not tell anyone else. There was inadequate business process to inform the Tartan and Claymore platforms to quit pumping oil and gas to Piper Alpha.

In conclusion, all these precious lives – along with their grieving family and friends – were impacted by preventable, predictable disasters. Let's learn from these mistakes and not let them happen again.

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