Process Safety: Keeping the Peace in a post war Age.

Tools and Techniques to contain Process Incidents in the current stable, low frequency scenario

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Outline

In the High Hazard Process Industry, we have entered a stable, low Process Incident frequency phase – effectively, a post war state. Can the impact of Peacekeeping intervention following real war ceasefires, provide any lessons to help us maintain the current status quo in Process Risk Management.

Abstract

The war on Process Incidents has been raging for 200 years. As processing facilities evolved, the hazards they contained mutated, becoming bigger, more toxic and more energetic. As the hazards advanced, we improved designs, developed more robust barriers and reshaped culture. By first decade of the 21st century, the hazards appeared to have been subdued – as far as reasonably practicably.

So, if, finally the war has been won, how can we now best keep the peace?

This paper briefly describes the history of the long war against Process Incidents, examine whether any of the Peacekeeping Scenarios set out in Page Fortna's book 'Does Peacekeeping Work?':

Observation; Inter-positional; Multidimensional; Peace enforcement

could be applied to the ongoing constraining of Process Incidents

Introduction

Does Peacekeeping save lives? According to the research conducted by American Academic Virginia Page Fortna, demonstrably so. In her book 'Does Peacekeeping Work?' [Ref 1] she analysed the chronology following civil war cease-fires in the 1990s, where peacekeeping and peace enforcement missions were deployed in 36 cases, while not in the remaining 58. She discovered that Peacekeepers being deployed reduces the risk of another war by 55-60%. Before the implementation of successful Peacekept cease fires: Mozambique (1992-94); Sierra Leone (1999-2006); Liberia (2003-2018) there were more than 1 million conflict related deaths, which equates to hundreds of thousands of future lives saved by Peacekeeping intervention.

Although orders of magnitude less dangerous than the civil wars, Process Safety incidents in the High Hazard Processing Industries (Oil and Gas Production, Chemicals, Fertilisers etc) have led to the preventable deaths of thousands of people over recent decades, including:

- December 3, 1984: The Bhopal disaster. A runaway reaction in a tank containing poisonous methyl isocyanate caused the pressure relief system to vent large amounts to the atmosphere. Death toll up to 20,000.
- July 6, 1988: Piper Alpha disaster. An explosion and resulting fire on a North Sea oil production platform killed 167 men.
- March 23, 2005: Texas City Refinery explosion. An explosion occurred at a BP refinery in Texas City, Texas. Over 100 were injured, and 15 were confirmed dead.
- April 20, 2010: Deepwater Horizon oil spill in the Gulf of Mexico. Eleven oil platform workers died in an explosion and fire that resulted in a massive oil spill in the Gulf of Mexico.

Figure 1: Image of the Piper Alpha Disaster

The second key question that Fortuna poses in her book is: as post-conflict peacekeeping works, how does it do so? In this paper I review some of the methods successfully applied to see if any could be mapped to the High Hazard Processing Industries (HHPI) to help us maintain process safety momentum in the equivalent of a post war period.

The Start of the War

The HHPI war on Process Risks started over 200 years ago. E.I. du Pont founded his eponymous company in 1802, setting up a gunpowder mill at Brandywine Creek in Delaware.

Figure 2: Original DuPont powder wagon

The initial years of manufacture were relatively incident free. However, a serious explosion occurred in 1818 resulting in 34 deaths. Mr DuPont recorded '... the magazine blew up with the most tremendous report I ever heard. Looking up, we beheld an immense cloud of white, thick smoke filling with dark objects, stones, beams, etc., the debris of the building and its contents. All that was left was a big hole in the hill and two acres of desolation' [Ref 2]. The company would have been bankrupt had a supplier had not agreed to accept a late payment, allowing the mills to be rebuilt over the following year.

The accident was investigated, conclusions drawn and new safety measures put in place.

- Mill workers had to wear boots held together with wooden pegs instead of iron nails.
- Cart-horses wore leather coverings over their metal shoes.
- A narrow-gauge railway connecting the various buildings at the plant site not only ran on hydropower but also on meticulously crafted wooden tracks.
- The cooling fans in the machine-repair workshop had blades of lacquered leather.
- The oil-lamps providing light for the machinists were carefully encased in glass and burned whale oil instead of the petroleum oil that had recently been discovered in the neighbouring state of Pennsylvania.
- The poorly refined petroleum product was avoided due to its tendency to spit when burnt.
- Mr DuPont preferred to hire inexperienced workers and train them in the rules and procedures that he knew would produce superior powder and minimise the risks of injury and death

And these measure were successful. Two years later, there was another explosion and as EI Du Pont noted in his journal 'nobody was injured and it has proved a fair experiment that upon the plan on which our mills are now built we have not to fear any general explosion like the one which happened here 2 years ago. From the particular construction of the mill the effects of the explosion have been directed in such a way so as not to communicate to any other part of the works [Ref 2]'.

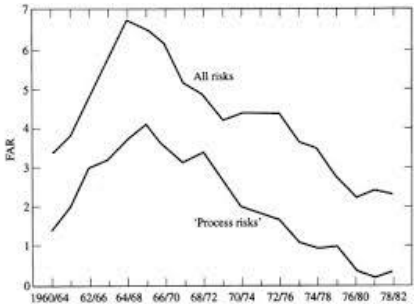
The struggle against Process Risks had begun.

How Was the War Won?

Imperial Chemical Industries, a major UK chemical company of the last century, were able to buildnew plants in the 1950s and 1960s were larger than earlier ones and operated at higher temperatures and pressures. One of the consequences was an increase in serious accidents. Accordingly, when losses of that containment occurred, they did so with increasing impact. Indeed, the fatal accident frequency among workers doubled in the 8 years from 1960. Something had to be done. And it was. According to Trevor Kletz, a key figure in the development of the concept of Process Safety, 'this led to the more systematic and technical approach to safety, known as loss prevention. Its distinguishing features include the quantification of risk, the identification of hazards by HAZOP, audits, inherently safer design, more thorough investigation of incidents, better incident reports and the study in much greater depth than before of explosions, runaway reactions and the dispersion of leaks [Ref 3]'. HAZOP was preferred to Inherently Safer Design as it was easier (cheaper?) to adopt at a lower organisational level and were therefore more likely to be adopted.

And it worked. Within 12 years, the FAR had been reduced by over 70% meaning that ICI's implementation of HAZOP and other supporting techniques saved around 50 future lives.

Figure 3: ICI Fatal Accident Rate from Process Risks 1960-82. [Ref 3]



In the subsequent decades of the 20th century, Process Safety was further enhanced by the development and implementation of quantitative techniques such as SIL and LOPA and legal paradigms such as ALARP. Process Hazards were increasingly corralled and contained, to the extent that, by the start of the current century, I would argue, the war against Process Risks has been won.

However, the toxic, flammable, explosive, pressurised, asphyxiating hazards are still present. The only way to eliminate them is to abandon a series of industries upon which a significant part of affluence is based – Oil for Transport; Gas for Energy and Power; Fertilisers for productive farming to name but three. So, these Hazards still need to be contained for as long as we still rely on the industries in which they are embedded.

Psychologist Daniel Kanheman notes that one of the psychological challenges is that we tend to over-estimate the likelihood of an event recurring when it has just happened but progressively under-estimate it as time passes [Ref 4]. My own vignette on this is the only time I was nervous as I drove over the Forth Road Bridge in Scotland was soon after some of its supports fractured, leading to the bridge's temporary closure for repair. This is illustrated by the following graphic:

Figure 4: The Process Risk Cycle

We risk being lulled into a false sense of security, precisely because, the ending of the war on Process Risks equates to major incident frequency becoming very low and steady

The Case for Peacekeeping Success and it's Mapping to Process Risk Intervention

According to its own website 'UN Peacekeeping helps countries navigate the difficult path from conflict to peace. We have unique strengths, including legitimacy, burden sharing, and an ability to deploy troops and police from around the world, integrating them with civilian peacekeepers to address a range of mandates set by the UN Security Council and General Assembly.' [Ref 5]. It was founded in 1948 and as of 2019, there were ~100,000 people serving in UN peacekeeping operations (90 % uniformed, 9% civilian, and 1% volunteers). [Ref 6]. It has a budget of ~$8bn and in January 2019) was active in 14 locations.

Figure 5: UN Peacekeeping in Action

Are there sufficent similarities between the belligerents in a Civil War and the Stakeholders and Hazards in a High Hazard Processing Operation? Let's consider at the belligerent characteristics of Process Hazards:

- pressurised,
- flammable and
- toxic hydrocarbons;
- size and strength matter;
- absence of intelligence;
- predictable response to LOC;
- like rebels in a peace kept conflict, hazards are often undetectable when they are contained.

So overlap in several areas. Enough, I believe, to merit further investigation.

Also, does Civil War Peacekeeping itself work (compared to non-intervention following a civil war cease-fire)? According to the research conducted by American Academic Virginia Page Fortna, it does [Ref 1]. She analysed the chronology post civil war cease-fires in the 1990s, where peacekeeping and peace enforcement missions were deployed in 36 cases, while not in the remaining 58. She discovered that Peacekeepers being deployed reduces the risk of another war by 55-60%.

In her book, she describes 4 types of peacekeeping:

- *Observation*
- *Inter-positional*
- *Multidimensional*
- *Peace enforcement*

Two other categories which I identified separately are:

- *Transition Assistance*
- *Using your 'Smarts' – the application of psychological nudges*

Let's consider each type and see if there are any useful Process Risk Mappings.

Observation

Observation Missions consist of small contingents of military or civilian observers tasked with monitoring cease-fires, troop withdrawals or other conditions outlined in the ceasefire agreement. They are typically unarmed and are primarily tasked with observing and reporting what it taking place.

Ms Fortuna argues that observation encourages compliance. It does this by increasing trust between the parties and gives front line soldiers confidence that other protagonists in the conflict are respecting the agreement.

I believe that there are useful parallels in High Hazard Processing Industries. RasGas, the Qatari LNG producer, which is now part of QatarGas, runs an operator care program where operators are supported to act as owners of the equipment for which they're responsible. A key element of this program is Senior Management encouragement of front line decisions to stop production if they sense 'things are not right'.

Another mapping of Process Risk Observational Success is the 2016 HSE Audit of Eley.

Figure 5: Eley Company Logo

At the start of 2016, Eley, the world's premier manufacturer of sports bullets, received a visit from an HSE inspector, who quizzed them on the manufacturing process for their explosive tetrazene. Among his enquiries, he asked about credible deviations and was unsatisfied with the responses. He advised them to undertake a HAZOP of their process before he returned later in the year.

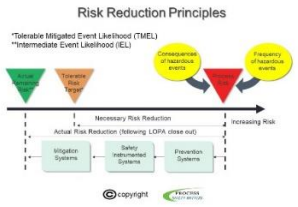
Accordingly, they looked for a HAZOP course and subsequently enrolled on one I was presenting on behalf of the IChemE in March 2016. At the end of the course, we agreed that I would set up and facilitate an initial HAZOP for them, which they would use as a template for the rest of their facility.

Fast forward to 2022. Eley completed all the HAZOPs for their chemical manufacturing process. They developed a program to cyclically revisit the program, which has been initiated. They are fully committed to their new relationship.

Inter-positional

This type of operation is conducted as a means of keeping two opposing military forces apart, in the aftermath of hostilities while negotiations for a peace agreement are in progress. This requires the interposition of an impartial force between the belligerants, the establishment of a buffer zone and continuous monitoring of the agreement. The size of the force and its concept of operations will depend upon the terrain, the availability of peacekeeping units and the specific requirements necessary to achieve control of the buffer zone and the separation of the opposing armed forces.

Figure 7: Process Risk Mapping – Safeguards between Process Safety Risk and TMEL



Multidimensional

‘Today’s multidimensional peacekeeping operations are called upon not only to maintain peace and security, but also to facilitate the political process, protect citizens, assist in the disarmament, demobilisation and re-integration of former combatants; support the organisation of elections, protect and promote human rights and assist in restoring the rule of law [Ref 1]’. The mapping to Process Safety is more challenging here, but as organisations become flatter and more role fluid, Process Safety Professionals have the opportunity to try to embed their previously siloed practices into company culture.

Peace Enforcement

Peace enforcement refers to the use of military assets to enforce a peace against the will of the parties to a conflict when, for instance, a ceasefire has failed. Peace enforcement often exceeds the capacity of peacekeeping forces and is thus better executed by more heavily armed forces.

Figure 8: Deepwater Horizon Disaster

A Peace Enforcement Process Risk Mapping is BP’s Actions following Deepwater Horizon Disaster.

The Deepwater Horizon disaster cost BP $50bn, its CEO and severely impacted its corporate reputation. During the months which followed, the new CEO, Bob Dudley, instigated measures to address the root causes of the incident. These included:

Competence and Capability Development

Our training and development programmes enhance the capability of our staff at all levels to deliver safe, reliable, responsible and efficient operations. We are incorporating learnings from the events of 2010, particularly around the practical application of process safety. We are introducing an additional term on process safety and systematic management at our Operations Academy for senior operations leaders and have rolled out a Managing Operations programme to mid-level leaders on continuous improvement, process safety management and the OMS. We also continue our Operations Essentials programme for frontline leaders and technicians, which seeks to embed the BP way of operating as defined by our OMS. [Ref 7]

Auditing their Safety Performance

The BP global safety and operations audit team, working independently of the operating sites, assesses the site against predefined protocols. This work is essential to our safety management as it helps us to measure the effectiveness of our operational risk management activities. The audit team produces its findings and agrees the actions with the site’s leadership.

Over time, the audit team tracks the site's progress against these corrective actions and verifies completion. The audit team reports quarterly to executive management, highlighting any outstanding issues. The board's safety, ethics and environmental assurance committee reviews the audit results annually. By the end of 2010, the team had completed 120 audits in total. More than 12,000 actions have been raised, with approximately 9,900 closed out. [Ref 7]

Implementing Bly Report

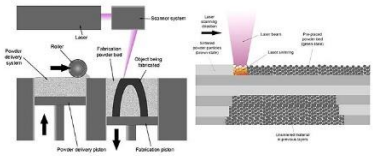
Recommendation 18 – *To require hazard and operability (HAZOP) reviews for surface gas and drilling fluid systems for all BP-owned and BP-contracted drilling rigs*. Implemented by 2013 [Ref 8].

Transition Assistance

This type of operation is initiated to support the transition of a country to peaceful conditions and an acceptable political structure after a civil conflict or struggle for independence or autonomy. The peacekeeping force attempts to effect an end to violence, to foster an environment in which the achievement of a negotiated settlement by the parties in conflict. The execution of this mission will probably require a large peacekeeping force, with distinct and often co-equal military, civil police and civil administrative components. There must be close and continuous coordination of the activities of all these components as well as other agencies, such as the UNHCR. [Ref 9]

The nature of the risks in HHPIs is never constant. Although the key sectors therein are relatively mature, technology develops. For example, increased automation – hardware and software, with the associated risk of latent failures; cyber-attacks; man/machine interface evolution. Furthermore, new HHPI sectors are created (as they were when Bayer upscaled the Haber process for Ammonia generation a century ago). Examples include Nanotechnology and Additive Manufacture, an example of which is direct metal laser sintering (DMLS), which uses lasers to melt and fuse metallic powders to rapidly and efficiently create complex 3D industrial parts.

Figure 9: DMLS Schematic



The hazards associated with this new industry include: dispersion of metal powders (potential carcinogens); Exposure to argon (asphyxiation); electrostatic discharges (potential for metal dust explosion); laser radiation.

Figure 10: DMLS Operator

Jens Rasmussen argues that in the presence of strong cultural and psychological forces (Corporate towards efficiency, Individual towards least effort) human behaviour are likely to migrate towards the boundary of acceptable performance. [Ref 10]

Figure 11: Rasmussen Organisational Risk Landscape

When the hazards are new or unknown, it is imperative to quickly understand and mitigate them before this boundary is breached, leading to an accident. Accordingly, appropriate safeguards need to be conceived and provided as these new hazards are identified, rather than in response to major incidents and their associated fatalities (which has been the standard HHPI chronology since Du Pont's day).

Using Your 'Smarts'

Peacekeeping forces often find themselves in invidious circumstances: places between or amongst usually significantly larger numbers of former belligerents, armed for protection and intervention only as a last resort. In these extremely challenging circumstances, perhaps their best weapon is one which has no physical form – psychology. The ability to engage with a stranger, to put them at their ease and get them to accept your position is often best achieved behaviourally. One way to do this is to 'nudge' them out of aggressive and violent disposition.

In their 2009 book of the same name [ref 17], authors Thaler and Cass argue that 'People have a strong tendency to go along with the status quo or default option'. 'Roughly speaking, losing something makes you twice as miserable as gaining the same things makes you happy'. Accordingly, this 'loss aversion produces inertia, translating to a strong desire to stick with your current culture'. Nudging implies changing, perhaps gradually, the architecture of the context in small but significant ways, such that the inhabitants are either unaware of the change or aren't panicked by its pace. Welcome to their world of 'Libertarian Paternalism: the idea that it is both possible and legitimate for private and public institutions to implement ideas which affect behaviour while, at the same time, respecting freedom of choice'. Examples of how learnings from the book this can be applied to Process Safety Peacekeeping include:

- Acknowledging that 'Individuals make pretty bad decisions – decisions they would not have made if they had paid full attention and possessed complete information, unlimited cognitive abilities, and complete self-control.'. I have found that, by postponing a thorny issue at the end of a HAZOP day until the following morning, the discussion time is significantly reduced – 30 to 5 mins
- 'Adults can be greatly influenced by small changes in the context.' Similar and geographically close process operators can often have wide variations in their appearance which is linked to Process Safety culture. Eley, a Birmingham based explosives company I have worked with has a spotlessly clean and tidy plant. They may be amenable to offering a plant tour if requested by neighbouring facilities
- 'Accessibility and salience are closely related to availability and they are more important as well.' (Fortunately, PS incidents are very infrequent, but this means that they are neither accessible or salient. This is exacerbated if companies down-play, ignore or even deny minor incidents or 'but for luck' near-misses. In recent Linde SABIC ASU 9 HAZOP, which I chaired, SABIC were pro-active in highlighting incident, near misses, including root causes from previous ASU projects (1-8) as contextual info to help improve outcomes and lower residual risk while expanding their accessibility and salience.)
- 'The pervasive problems are that easily remembered events may inflate people's probability judgements and that if no such events come to mind, their judgements of likelihoods might be distorted downwards.' (In my Hazards 28 presentation 'The Gamification of Process Safety', I suggested Near Miss intervention could be highlighted and rewarded by generating a simulation/animation of the event)
- 'It turns out that if you ask people, the day before an election, whether they intend to vote, you can increase the probability of their voting by as much as 25%' (Toolbox talks reminding teams of safety feedback forms and monthly prize draw)
- 'If you indirectly influence the choice other people make, you are a choice architect'. As part of a post incident process safety audit I led for an upstream facility in Iraq, a H2S release safety drill was planned. However, the day before, there was a spontaneous alert, which was well responded to. It made me think that, whether the spontaneous alert was real or contrived, it created a context where the operators reacted 'as if it were real' and gaining the experience and learning therefrom. I suggested to the site owner that the incident response could be improved if operators were aware that there would be a mix of announced and unannounced drills over time.

Over recent years, UN Peacekeeping has had its share of successes and failures. The challenge, as with Process Risk, is that when things go well…..

- Sierra Leone (1999 – 2005)
- Liberia (2003-2018)
- The High Hazard Process Industry (2000-present)

…..the audience is uninterested even bored.

Sierra Leone

Figure 12: UN Secretary General Ban Ki Moon, Officially Ending the Peacekeeping Mission to Sierra Leone in 2006

'The UN peacekeeping force that operated in Sierra Leone from 1999 to 2005 is hailed as a success. It was created to help implement a peace agreement after the country's devastating civil war.

Mr Ban officially closed the UN offices in Freetown in 2014, declaring a "successful conclusion" to the organisations work in helping to bring peace to the country, calling it a "triumph for the people of Sierra Leone" after what had been a decade of warfare. "Our blue helmets disarmed more than 75 000 ex-fighters, including hundreds of child soldiers. The UN destroyed more than 42,000 weapons and 1.2 million rounds of ammunition – a potentially deadly arsenal that is now itself dead," Mr Ban declared [Ref 11].'

Liberia

Figure 13: Declaration of the Successful Completion of the UK Peacekeeping Mission to Liberia in 2018

Liberia, the first independent country in Africa, enjoyed nearly a century and a half of stability before falling into chaos, enduring two devastating civil wars between 1989 and 2003.

More than a quarter of a million Liberians were killed and nearly a third of the population was uprooted. By some reports, 80 per cent of Liberian women and girls suffered conflict-related sexual violence.

The Security Council established the peacekeeping mission for Liberia in October 2003, as violence lingered even after warring factions agreed to a cease-fire and a plan for political rebuilding.

As peacekeepers first arrived, "the entire country was in turmoil," recalled Lt. Gen. Daniel Opande, the first commander of UN forces in Liberia, in a recent interview. "People were moving from place to place, looking for safety or for food."

A newly secure environment enabled more than a million refugees and internally displaced persons to return to their homes. The Government established its authority throughout the country and by now has successfully held three presidential elections.

Some 16,000 personnel from more than a dozen countries served with UNMIL. Their service did not come without sacrifice; 200 peacekeepers lost their lives due to illness, accidents or other causes while serving in Liberia.' [Ref 12]

However, despite these tremendous achievements, the world's press isn't, generally, excited enough to report (because they judge that their readership probably won't be excited enough) on an absence of killing.

However, when things don't go well….

- Srebrenica 1995
- Somalia 1993
- BP Gulf of Mexico Disaster 2010

…the audience, sadly, become aroused,

Srebrenica

Figure 14: Srebrenica Dead

On July 11, 1995, towards the end of Bosnia's 1992-95 war, Bosnian Serb forces swept into the eastern Srebrenica enclave and executed 8,000 Muslim men and boys in the days that followed, dumping their bodies into pits. It was the worst massacre in post-Second World War European history. The UN had previously declared the town one of the safe areas, to be "free from any armed attack or any other hostile act". 600 Dutch infantry were supposed to be protecting thousands of civilians who had taken refuge from earlier Serb offensives in north-eastern Bosnia. [Ref 11]

Somalia

Figure 15: Aid Distribution in Somalia

The UN operation was the first time the peacekeeping force had been used for “humanitarian intervention”. However, the peacekeepers were met with a hostile reception in Mogadishu. Several of them were killed and the bodies of dead US soldiers were paraded through the streets on the orders of the Somali warlords. [Ref 11]

In these cases, there is significant press coverage, mostly due to their judgement that their readership (you and me) will be excited by the associated violence, death and destruction. Psychological reaction to fear & excitement is very similar. In fact, high grossing films were made about some of these scenarios:

- Somalia - Black Hawk Down (2001. Receipts $171m [Ref 13])
- BP Gulf of Mexico Disaster - Deepwater Horizon (2016. Receipts $139m [Ref 14])

So, what, if anything, can we learn from these high-profile examples of UN ceasefire intervention? For me, key aspects include:

- Transparency engendering experiential learning and improvement. Operations such as Somalia and Srebrenica were extensively reported by Media Organisations, in addition to the UN’s own review and analysis. Lessons were learned and put into practice in future missions:
    - Following Srebrenica, a new mission category – peace enforcement – was agreed, developed and implemented from Kosovo onwards.
    - Dynamically determining the right size and character of the mission enabled the successful interventions to make an initial impact and then evolve over time with the local circumstances.
    - The commitment of the Peacekeeping stakeholders to maintain and sustain support over the long term.

Process Safety Related Peacekeeping Learning

Ms Fortna argues that ‘Peacekeepers can have a causal, rather than spurious, effect on the stability of peace if (1) they reduce the likelihood of aggression by raising the costs of war or the benefits of peace for the peacekept; (2) they disrupt spirals of fear and scurity dilemmas by reducing belligenrents’ uncertainty about each other’s actions and intentions; (3) they prevent accidents from occurring or control them so that they do not escalate to war; or (4) they can deter or prevent one side from reneging on a political deal and excluding the other from power.’ [Ref 1]

I believe there are important ideas which flow from these tenets, which could help 21st century Process Safety.

(1) they reduce the likelihood of aggression by raising the costs of war or the benefits of peace for the peacekept;

Mapping to Process Risk Intervention, we can leverage this finding by: emphasising the financial benefits of determining operator's optimal Process Safety Return on Investment;

Figure 16: Optimising Process Safety ROI

include the benefits of improved uptime (psychologically more positive) and personalising future lives saved (opposite of the unknown soldier – designated survivor: ops get to vote for PS champion when one future life is saved – bonus, recognition)

(2) they disrupt spirals of fear and scurity dilemmas by reducing belligenrents' uncertainty about each other's actions and intentions;

Fortuna found that UN observers were necessary because 'you needed people to track movements, to do head counts' of demobilising troops and so on'. One example involved the UN's monitoring of elite troops the gov 'hid' in the Presidential Guard (part of the police force) as a hedge. 'In the military field, Ajello asked the UN police forces to do surprise inspections of the Presidential Guard. The government was furious, but there were suspicions that demobed soldiers were secretly being transferred to the Presidential Guard and trained (in violation of the accords). This was discovered by the UN, things were called what they were' [Ref 1].

In this case mapping to Process Safety Intervention might mean doing the opposite: ***inducing*** *the uncertainty and fear that drives security dilema sprials by, for example, communicated but unplanned audits. These surprise visits could be explained in terms of reflecting human nature ('this is what we're all prone to') rather than lack of trust in workers and be spread evenly across the company hierarchy.*

(3) they prevent accidents from occurring or control them so that they do not escalate to war; or

Fortna reported that the cooperation of the Renamo leadership (Dhlakama; Mozambique Civil War) was more direct, involving cold hard cash. The UN bought Dhlakama's cooperation with millions of dollars in a trust fund nominally set up to help Tenamo transform itself into a political party. According to one report, when a UN offical offered Dhlakama a check for the first installment, he examined and returned it saying he wanted it in cash. An international observer of the peace process put it this way: 'the payments to Dhlakama helped keep him in power. He needed patronage to dole out, otherwise he would have been dead (literally)' [Ref 1].

Here Process Risk Intervention could be zero tolerance of fugitive emissions, with an operations bonus linked to numbers decrease (being willing to set a default bar in case of large-scale emission in any one year). Also, funds need to be spent wisely and not necessarily logically or morally. You may have to do things which make you corporately uncomfortable. And then, make sure you report on improvements made, or be willing to change course if the intervention proves to be unproductive.

(4) they can deter or prevent one side from reneging on a political deal and excluding the other from power.

RasGas Operator Care provides a counterweight to production primacy

PKers are most likely to be sent where they are most needed, where the job of maintaining peace is most difficult.

Identify where the most intractable PS issues remain (industries, companies, countries) and focus resources there.

Peacekeeping is not a cure all. Beyond the task of maintaining peace, the international community increasingly aims to foster democracy in the war-torn societies in which it intervenes. While peacekeeping is clearly effective at maintaining the peace, it has not necessarily left significantly more democratic societies in its wake.

Process Hazards & Fundamental Human Nature are impervious to Process Risk Intervention. However Organisational Culture, Structure, Design Philosophy informing Basis of Design may not be. This may be easier to achieve where High Hazard Processing Companies are privately or nationally owned, where the ultimate owner (a few individuals, a few Politians) are likely to be more engaged with any major PS incident than those of a PLC (multitudinous individuals and organisations). An example is INEOS, a $60bn turnover High Hazard Processing company, which operates around 100 sites. Jim Radcliffe, founder and majority shareholder in the company, says in his book 'the Alchemists' [Ref 15],

Figure 17: Jim Ratcliffe

'We hold some 20 board meetings (ExCos), one for each subsidiary, each month, that both Andy and I attend. The first item on the agenda is always safety. Not just personal, but process safety too. It is mandatory for each board in INEOS to report key safety metrics each month. The detail is such that Andy and myself are aware of the safety performance of each and every business down to details, which means any overdue maintenance inspection, any loss of containment, any recordable injury, any HiPo (high potential) incident, any major alarm activation.'

He goes on further to state 'Rigour is my favourite word in business. You need to understand risk, weigh up risk and take a view.'

Peacekeeping is not free. It costs money and personnel on the part of the international community and the countries that contribute troops. Sustaining this support, for both Civil War and HHPI intervention, can only be helped when intervention success is apparent.

Metaphor Learning and Intervention Tools

I believe that UN Intervention in recent Civil War Cease-fires is a imperfect but useful metaphor for the current state of Process Safety in High Hazard Process Industries, There are several things we can learn from mapping relevant findings of the former to *optimisation for the latter and linking them to new and putative intervention tools*:

- Observation improves compliance
  - *Implement an Operator Care Program*
- Transparency and Communication increases trust uptake of learning from Incidents
  - *NH3 Operators Incident Database [Ref 16]*
- The more senior in the organisational hierarchy Peacekeeping behavour is observed, the more impactful it is on Organisational Culture.
  - *Potential correlation between number and engagement of operating company stakeholders and Process Risk outcomes*
- Intervention is positively correlated with Operational Difficulty
  - *Identify where the war on Process Safety Risk (Regions? Industries?) is still smouldering and focus resources there*
- Inate Human and Organisational Behaviour require dynamic vigilance as situations evolve
  - *Novel HHPI risks will not necessarily respond predictably to existing Process Risk barriers*
- Emphasising the benefits of non incidents can be as, if not more, beneficial as impact of incidents
  - *Accentuate the positive – personalising future lives saved (opposite of the unknown soldier – designated survivor: ops get to vote for PS champion when one future life is saved – bonus, recognition)*
- A zero tolerence approach to loss can prevent escalation
  - *zero tolerance of fugitive emissions, with an operations bonus linked to numbers decrease (being willing to set a default bar in case of large-scale emission in any one year)*
- Appointing a referee who is trusted by and willing to listen to the conflict stakeholders
  - *HSE in the UK and a possible model for other countries and regions*
- Become a Choice Architect
  - *Communicate and carry out unplanned audits which, when they occur, are well publicised in a balanced way*

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