

Embedding the Lessons of Hard Knocks

Trying Not to Repeat Our Mistakes Time and Time Again

Dr Ken Patterson & Gillian Wigham



Dr Ken Patterson

Originally an Industrial Chemist, Ken joined HSE in 1986 as a specialist inspector, dealing with process safety. He worked both in the field and spent periods in HSE HQ, in Major Hazards and Operational Research. He moved to Hickson & Welch in 1994, after the company's major accident, as their Health and Safety manager. He retired in 2015 after 10 years with Synthomer firstly as their European and then as the Global SHE manager.

Ken was a member of the working group which wrote IChemE's "Fundamentals of Process Safety" course, which he has taught many times since. He chaired the working group which produced the third edition on CIA's Occupied Buildings guidance and was a member of the UK's Chemical Weapons Convention Advisory Committee. In 2011 he was awarded the Franklin Medal by IChemE for his work in process safety.



Gillian Wigham

Also an Industrial Chemist, Gillian has over 30 years experience in the chemical industry having worked as a Research Chemist, Plant Support Chemist, Development Chemist, Occupational Health Manager, SHE auditor, Training Manager and Quality Manager.

Gillian joined Synthomer in 2005 from Hickson & Welch initially to support the European SHE Manager, specifically with Occupational Health and SHE procedures. Gillian now works for the corporate team, across the Group's global sites, as Group SHE auditor and Occupational Health advisor.

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IChemE
ADVANCING
CHEMICAL
ENGINEERING
WORLDWIDE



- A leading global supplier of water-based and differentiated polymers with 2020 revenues of £1.65bn; Headquartered in London (UK)



- An international footprint across 18 countries, with 37 manufacturing sites and 4 Innovation Centres located in Europe, North America and Asia



- A strong track record of organic growth and M&A



- ca. 4750 employees around the world

FTSE
250

- Listed on London Stock Exchange since 1971; Market Capitalisation ~£2bn

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What do we know?

- The duty of old people is not to tell young people what to do
 - when did that ever work?
- Old people should tell young people what we have got wrong, so young people at least have the chance to make their own mistakes.
- We do, collectively, know a lot about how to do things safely, much of it learned from our (and other's) mistakes.
 - The history of engineering, at least since the birth of the railways, is a history of learning from what worked, or - possibly more often - from what went horribly wrong!

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We all make mistakes (and have always done so)



- Both the rail and airline industries have strong cultures of accident & near miss reporting and investigation, coupled with a strong “rule book” and constant learning from their mistakes.
- Both provide astonishingly safe modes of travel.
- However, both are very “self-similar”, they do the same thing time and again, with a relatively small set of material (aircraft types, locomotive types, airports, fixed track layout, etc).

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What does that mean in the Process Industries?

- The process industries are always innovating with little control on what type of process is allowed:
 - Reactors get bigger, storages get bigger, new processes are introduced ...
 - T2 industries accident: they used an “Innovative” temperature control system - boiling off the cooling water and replenishing it from time to time
- We also change what we have: we try to improve, streamline, remove manual operation - *and we change the people doing it.*
- We have developed Process Safety Management Systems (PSMS) to control these changes but they depend on fallible people making the right decisions,
 - How do we help our staff learn the things we think we know, and how do we keep that knowledge fresh as they take their decisions?

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Why do we repeat accidents – memories

- Human memory isn't consistent – “Chinese whispers”
- Hard to remember accidents in a neutral, unbiased way
 - Feel the emotion to make the memory, but remember the facts
- False details can reproduce
- How different people focus their attention on an event will affect what they remember
- Three aspects of memory that can fail
 - Encoding - how we get information into the brain
 - Storage - how we retain information over time
 - Retrieval - how we get information out of the brain

Only people have memories, not organisations

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Our best defence against repeat accidents?

“A systematic framework for managing the integrity of hazardous processes”
- our **PROCESS SAFETY** management system

- *Analyse the hazards - inherent, transient and potential - in every process and plant*
- *Think about the possible accidents before they occur*
- *Put appropriate barriers against them in place*
- *Manage the systems which keep the barriers effective to ensure they are working*
- *Embed the system in all your operations to make the process systematic and rigorous*

But these systems still always rely on humans

- so how do we keep them informed?

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Building and rebuilding memories - IChemE

IChemE invests in assisting in learning from accidents:

- Loss Prevention Bulletin
 - Approaching 50 years of publication, now free on-line to members
 - Searchable database of accident reports & summaries, plus good/best practice reviews
- SLPSIG - keeps available out-of-print HSE major accident reports
 - Newsletter has a round up of incidents with links to more information
 - Other SIGS & Area Groups regularly discuss accidents and the learning from incidents
- TCE - publishes reports and long-term reviews of major accidents on their anniversary (for example Fukushima, this year)

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Building and rebuilding memories - IChemE

IChemE is heavily involved in learning from accidents:

- The SIESO Prize for students asks “How do we present what we have learnt from accidents in new, innovative ways, likely to catch the imagination of today’s undergraduates & young engineers”
 - *And offers £750 for the best entry!*
- The “Fundamentals Of Process Safety Course” discusses significant major accidents as a way of introducing PSM and topics like PtW & MoC.
- However, typing “accidents” into a search of IChemE’s “Accreditation of chemical engineering programmes” produces 0 matches.
 - Not - of itself - a good or bad thing but perhaps an area to consider at some point?
 - The authors have lectured to students at Leeds & Bradford universities on Major Accidents.

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Keeping the knowledge in manufacturing: Process Safety Leadership

- Clear and positive process safety leadership is at the core of managing a major hazard business
- Leadership is vital to ensure risks are effectively managed
- Leaders must understand - and show they understand - the Company's Major Accident Hazards and PSMS
- Good process safety management does not happen by chance, it requires constant active engagement
- Sharing good practice and **learning and implementing lessons from incidents** are important aspects of process safety



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Keeping the knowledge in manufacturing: Management and Operations at every level

- Remember events
- Spread the knowledge
- Learn from our mistakes

Learning from our mistakes . . . The Synthomer Way . . .

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'Reporting incidents / near misses, solving root causes, sharing and implementing lessons learned'

Reporting

- Reporting and recording all injuries, incidents and near misses
- Investigating injuries, incidents and near misses so root causes can be determined
- Implementing actions to prevent reoccurrence
- Sharing lessons learnt and implementing lessons from others as 'If it was my site'

The Black Book

- A historical journey through the most significant Process Safety events in Synthomer history
 - Analysis of Company Accident and Incident data over the last 15 years
 - Site Challenge – What was your worst ever event ?
 - Compiled 'top 20' events
- Format
 - Photo
 - Summary - Site, Incident, Material, Quantity, Consequences
 - What Happened
 - Why did it Happen
 - Lessons Learnt
 - Colour coded Bow-Tie and accident time-line
- On average Synthomer had 5 chances to stop the 20 'worst' events the Company has had!

Blackbook Lessons Learnt #1
Reactor Mischarge

Incident: Loss of containment due to runaway reaction following monomer overcharge.
Material: Methyl Acrylate (MA)
Quantity: Estimated < 250kgs
Consequences: Ejection of solid 'golf balls' through vent and a 'solid' reactor.

What Happened?

- An uncontrolled reaction resulted from a significant overcharge of a monomer to the Polyacrylate Reactor.
- This resulted in a small amount of polymer (in the form of small 'golf balls') being ejected from the manual vent system as the temperature and pressure increased.
- The bursting disc and relief remained intact.
- The remaining contents solidified in both the reactor and the catch pot and took almost 3 weeks to high pressure jet out.
- The initiating event was the fact that an operator keyed in 15840 kg instead of 1504 kg of Methyl Acrylate, being confused by the decimal point position.
- Issues around bad information and communication then further contributed to the incident.

Why Did It Happen?

- Meter pre-set parameters too wide, allowing charge greater than the receiving vessel.
- The relevant SOP provided for Reactor charging did not include how to set the meter.
- The Operator did not work in the area on a regular basis. This task was therefore only carried out occasionally, hence he had not received suitable and sufficient instruction and training.
- The Operators realised that they couldn't get vacuum to the Polyacrylate Reactor, they assumed a blocked knockout pot was causing the issue and therefore failed to do any further root cause analysis.
- Based on the above, a decision was taken to abort the batch and add catalyst.
- The overcharged reactor then began to runaway.
- Working procedures had never been devised on what to do in event of an anomalous batch, and working practices were inadequate.

Lessons Learnt

- Ensure that it is not possible to pre-set addition values in excess of receiving capacity of the vessel
- For large volume charges, avoid charges with decimal point accuracy
- Ensure that only fully trained and competent operators run reactions. This means that it has to regularly be part of their working routines.
- Assessed refresher training should be provided where operators have not worked on a particular task for a long time, (suggest > 3 months).
- Ensure up to date SOP's exist for reactor control.
- Ensure operators are trained to look for and act on anomalous conditions and importantly stop feeds when a problem is encountered
- Ensure good communication channels with those required to provide technical advice to ensure before crucial decisions are made, an adequate root cause investigation has been conducted.

We always have time to work safely



Behind The Black Book

- What else can the Company do with the rich data-set held in the accident and near-miss data Synthomer has collected over the last 15 years?
- 10 Presentations explaining the technical details underlying a number of the Black Book incidents, “Behind the Black Book”
- Presentations developed by technical experts for technical staff.

Behind the Black Book



Runaway Reaction in Polymerisation Reactions

What is a Runaway Reaction and how do we prevent them?



The Yellow Book

- A historical journey through the most significant Occupational Health & Safety events in Synthomer history
- Many similar events led to same consequence
- Decided to compile in 16 generic groups of injuries
- Similar format to The Black Book but includes good practice photos/sketched/ images

Yellow Book Lessons Learnt #4
 Category – Slips, trips and falls at same level

At least 17 recordable cases in the last 10 years involving 12 different sites



Main types of events we have had

- Trips during loading/offloading and other hoses related activities, due to stumbling over or stepping on/off hoses in use or not properly stored
- Falls due to tripping when walking on surfaces with changes of gradient
- Falls due to slipping when stepping over wet surfaces and spillages
- Falls due to tripping over obstacles when making shortcuts through congested areas and not using the nominated routes, e.g stepping over small bund walls, stepping over low level pipe runs
- Trips and falls due to walking on uneven ground, e.g drain covers, pot holes, hardcore gravel

Why Did they Happen?

- Poor housekeeping leading to congestion in the area and obstructing normal exit routes
- Poor housekeeping of hoses, often left trailing across walkways and most dangerously at the bottom of steps or ladders
- Poor design of work areas with obstacles making access difficult
- Floor design in that generally having to operate in confined or restricted areas
- Inadequate risk assessment for the use of hardcore gravel for semi-permanent access to portable offices
- No robust maintenance processes to track and repair things like drain covers and pot holes
- Inadequate hazard awareness: Not noticing obstacles and trip hazards when working or walking in congested areas
- Poor behaviours due to inattention and rushing

Lessons Learnt

Ensure the following are in place:

- Have adequate systems, discipline and confirmations in place to ensure hoses are safely stored when not in use
- Ensure when in use, hoses are never placed at the foot of steps/stairs
- When hoses are in use ensure they are in 'open', well lit areas with reasonable access around them
- Where confined work areas exist, ensure the correct access/egress routes are clearly identified
- Ensure all work areas are appropriately lit, with minimal 'shadowing'
- Have regular routines to check for uneven surfaces and get them promptly repaired and barriered off as a hazard in the interim
- All work areas and tasks should be risk assessed using the 300 degree check process to foresee potential hazards of access and egress
- Where potential 'problem areas' exist – warning signage, refresher training and regular briefing will help if re-design not possible

Principles that failed

Yellow Book Lessons Learnt #4
 Category – Slips, trips and falls at same level

We always have time to work safely

Some Synthomer accidents

| Date | Site | Accident Description | Consequence | Investigation | Corrective Action |
|------------|---------|------------------------|--------------|-------------------------|-----------------------|
| 12/01/2018 | Site A | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 15/02/2018 | Site B | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 20/03/2018 | Site C | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 25/04/2018 | Site D | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 30/05/2018 | Site E | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 05/06/2018 | Site F | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 10/07/2018 | Site G | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 15/08/2018 | Site H | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 20/09/2018 | Site I | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 25/10/2018 | Site J | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 30/11/2018 | Site K | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 05/12/2018 | Site L | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 10/01/2019 | Site M | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 15/02/2019 | Site N | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 20/03/2019 | Site O | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 25/04/2019 | Site P | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 30/05/2019 | Site Q | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 05/06/2019 | Site R | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 10/07/2019 | Site S | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 15/08/2019 | Site T | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 20/09/2019 | Site U | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 25/10/2019 | Site V | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 30/11/2019 | Site W | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 05/12/2019 | Site X | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 10/01/2020 | Site Y | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 15/02/2020 | Site Z | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 20/03/2020 | Site AA | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 25/04/2020 | Site AB | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 30/05/2020 | Site AC | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 05/06/2020 | Site AD | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 10/07/2020 | Site AE | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 15/08/2020 | Site AF | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 20/09/2020 | Site AG | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 25/10/2020 | Site AH | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 30/11/2020 | Site AI | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 05/12/2020 | Site AJ | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 10/01/2021 | Site AK | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 15/02/2021 | Site AL | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 20/03/2021 | Site AM | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 25/04/2021 | Site AN | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 30/05/2021 | Site AO | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 05/06/2021 | Site AP | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 10/07/2021 | Site AQ | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 15/08/2021 | Site AR | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 20/09/2021 | Site AS | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 25/10/2021 | Site AT | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 30/11/2021 | Site AU | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 05/12/2021 | Site AV | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 10/01/2022 | Site AW | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 15/02/2022 | Site AX | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 20/03/2022 | Site AY | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 25/04/2022 | Site AZ | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 30/05/2022 | Site BA | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 05/06/2022 | Site BB | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 10/07/2022 | Site BC | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 15/08/2022 | Site BD | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 20/09/2022 | Site BE | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 25/10/2022 | Site BF | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 30/11/2022 | Site BG | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 05/12/2022 | Site BH | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 10/01/2023 | Site BI | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 15/02/2023 | Site BJ | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 20/03/2023 | Site BK | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 25/04/2023 | Site BL | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 30/05/2023 | Site BM | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 05/06/2023 | Site BN | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 10/07/2023 | Site BO | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 15/08/2023 | Site BP | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 20/09/2023 | Site BQ | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 25/10/2023 | Site BR | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 30/11/2023 | Site BS | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 05/12/2023 | Site BT | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 10/01/2024 | Site BU | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 15/02/2024 | Site BV | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 20/03/2024 | Site BV | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 25/04/2024 | Site BV | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 30/05/2024 | Site BV | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 05/06/2024 | Site BV | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 10/07/2024 | Site BV | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 15/08/2024 | Site BV | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 20/09/2024 | Site BV | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 25/10/2024 | Site BV | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 30/11/2024 | Site BV | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 05/12/2024 | Site BV | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 10/01/2025 | Site BV | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 15/02/2025 | Site BV | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 20/03/2025 | Site BV | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 25/04/2025 | Site BV | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 30/05/2025 | Site BV | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
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| 20/09/2025 | Site BV | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
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| 20/03/2031 | Site BV | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 25/04/2031 | Site BV | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 30/05/2031 | Site BV | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 05/06/2031 | Site BV | Slip over liquid spill | Minor injury | Investigation completed | Spill cleaned up |
| 10/07/2031 | Site BV | Tripping over hose | Minor injury | Investigation completed | Hose retracted |
| 15/08/2031 | Site BV | Fall from height | Major injury | Investigation completed | Guard rails installed |
| 20/09/2031 | Site BV | Slip on uneven ground | Minor injury | Investigation completed | Area marked off |
| 25/10/2031 | Site BV | Tripping over obstacle | Minor injury | Investigation completed | Obstacle removed |
| 30/11/2031 | Site BV | Slip on wet surface | Minor injury | Investigation completed | Wet area marked |
| 05/12/2031 | Site BV | Fall from height | Major injury | Investigation completed | |

Learning from our mistakes . . . The Synthomer Way

- Site Leaders “own” a physical copy of The Black Book
 - They must be able to demonstrate knowledge and understanding of its contents - *and* how the conclusions apply to their site and its processes
 - “Handing on” this understanding is a duty when a new manager is appointed (covered in the Management of Personnel Change for the handover)
- Site Leaders expected to know about major industry events
 - part of their competence assurance assessment
- Regular site routines to review the Black Book and the Yellow Book
- Anniversary articles on the Synthomer “Intranet” written by employees
- Anniversary webinars about major industry events from external speakers

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The Synthomer Way

- Synthomer's core values embed SHE at their heart
- The books demonstrate this in a way visible to employees and other stakeholders
- The Safety Vision is zero accidents or incidents
- The expectation is that all parts of the company's operations perform at least as well as the Industry's top quartile
- The Journey to the vision continues ...

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Conclusions

- Process Safety Management Systems are the key
- Don't forget . . . but remember the facts
- Embed the lessons from the past
- Treat every piece of information as “if it happened on my site”

And a Question:

“If Synthomer represents good practice what can IChemE (and this Hazards Conference) do to make this good practice more widely followed/available?”

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Embedding the Lessons of Hard Knocks

Trying Not to Repeat Our Mistakes Time and Time Again

Dr Ken Patterson & Gillian Wigham