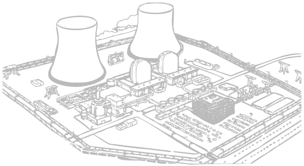


Learning from incidents and accidents

Eric Marsden

<eric.marsden@risk-engineering.org>

> *Human beings, who are almost unique in having the ability to learn from the experience of others, are also remarkable for their apparent disinclination to do so.*
>
> *— Douglas Adams, author of The Hitchhiker's Guide to the Galaxy*

Operational experience feedback

- Most companies with high-hazard activities have a formalized process for **analyzing incidents** and **learning from experience**
- Terminology used depends on the industry sector:
  - chemical industry: event analysis, learning from incidents (LFI), after-event reviews
  - nuclear industry: operational experience feedback
  - railways: learning from operational experience
  - military: lessons learned analysis
- This activity is often a requirement imposed by the regulator
- A complement to the accident investigation process

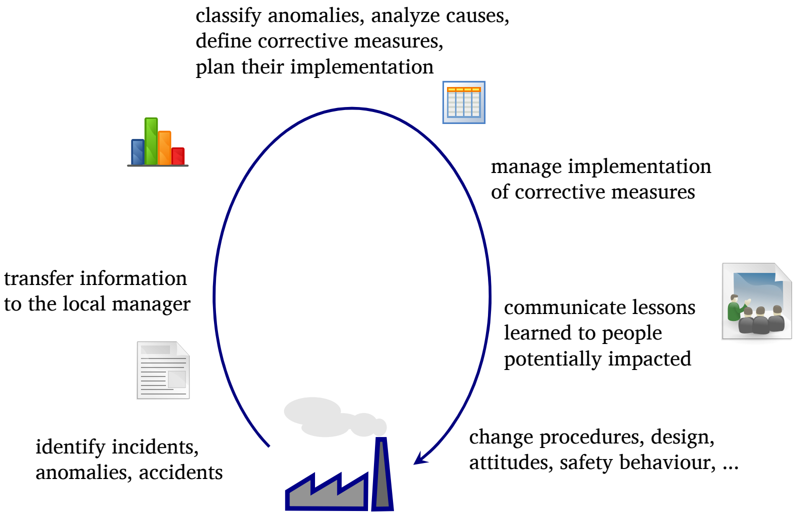
In these slides, we will use the term "operational experience feedback" or OEF

RISK ENGINEERING

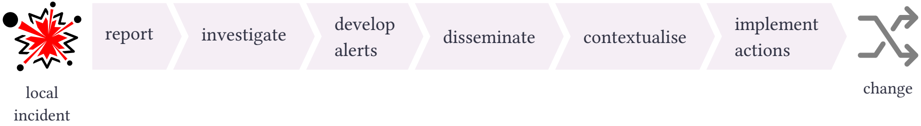
Operational experience feedback

- Operational experience feedback is a structured process aiming to **learn from past events** in order **better to control the future**
  - collect information on anomalies, deviations, near misses, incidents and accidents
  - analyze the sequence of events and their causality
  - extract new knowledge or learning from the analysis
  - implement corrective actions or action plans
  - share the learning with all interested parties
  - record the learning so that it can help people in the future
- It's related to the idea of **continual improvement**
  - identify improvements based on day-to-day operations
  - PDCA / Kaizen / 6σ …

The experience feedback loop

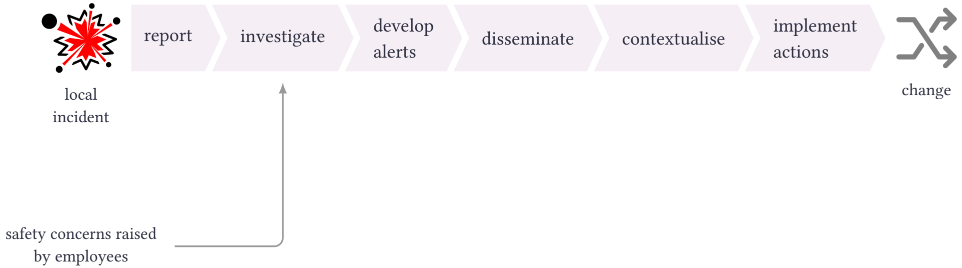


Phases in learning from incidents



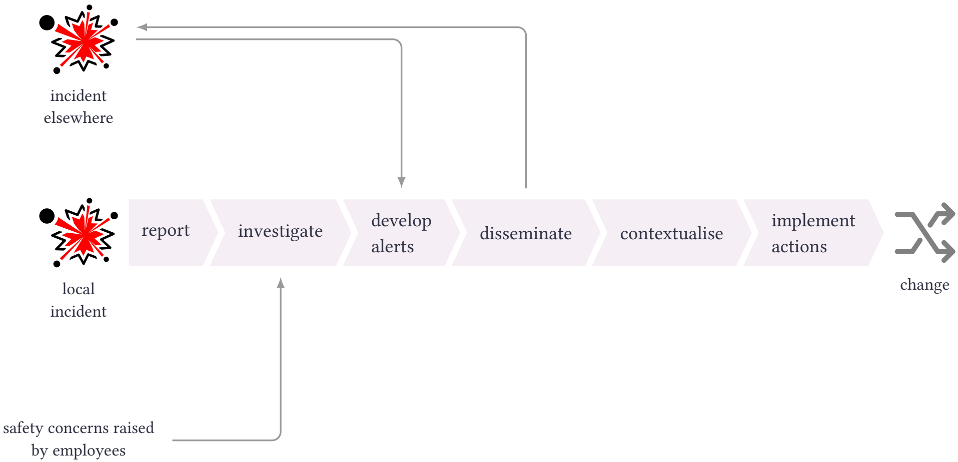
Source: Glasgow Caledonian University's LFI Process Model

Phases in learning from incidents



Source: Glasgow Caledonian University's LFI Process Model

Phases in learning from incidents



Source: Glasgow Caledonian University's LFI Process Model

Implementation at the site level

- **Reporting system** (paper forms or computer tool) to declare incidents, anomalies and accidents
  - specify the severity of consequences affecting people, the environment, production, process equipment
  - specify the severity level: for example catastrophic / high / medium / low
- For industrial sites that belong to a corporate entity:
  - monthly reporting to the corporate level on number of incidents affecting people, process, transport
  - immediately inform corporate level of events of high or catastrophic severity
- People on the site will also have **informal experience sharing practices**
  - safety discussion during team meetings
  - discussions at the water cooler

Sample reporting form used by the *Aviation Safety Reporting System* run by NASA for the US FAA, for incidents in civil aviation

Page 1: information on the person reporting and technical details of the incident

B

DO NOT REPORT AIRCRAFT ACCIDENTS AND CRIMINAL ACTIVITIES ON THIS FORM.
ACCIDENTS AND CRIMINAL ACTIVITIES ARE NOT INCLUDED IN THE ASRS PROGRAM AND SHOULD NOT BE SUBMITTED TO NASA.
ALL IDENTITIES CONTAINED IN THIS REPORT WILL BE REMOVED TO ASSURE COMPLETE REPORTER ANONYMITY.

(SPACE BELOW RESERVED FOR ASRS DATE/TIME STAMP)

IDENTIFICATION STRIP: *Please fill in all blanks to ensure return of strip.*
NO RECORD WILL BE KEPT OF YOUR IDENTITY. This section will be returned to you.

TELEPHONE NUMBERS where we may reach you for further details of this occurrence:

HOME Area _____ No. ____________ Hours ____________
WORK Area _____ No. ____________ Hours ____________

NAME ____________
ADDRESS/PO BOX ____________
____
CITY ____________ **STATE** _____ **ZIP** ________

TYPE OF EVENT/SITUATION
____
____
DATE OF OCCURRENCE ____________ (MM/DD/YYYY)
LOCAL TIME (24 hr. clock) ____________ (HH:MM)

PLEASE FILL IN APPROPRIATE SPACES AND CHECK ALL ITEMS WHICH APPLY TO THIS EVENT OR SITUATION.

REPORTER		FLYING TIME (in hours)	CERTIFICATES & RATINGS		ATC EXPERIENCE
O Captain O First Officer ☐ pilot flying ☐ pilot not flying ☐ relief pilot ☐ check airman	O Single Pilot O Instructor O Trainee O Dispatcher: _____ yrs O Other: _____	Total Time _____ hrs Last 90 Days _____ hrs Time in Type _____ hrs	O Student O Sport/Rec O Private O Commercial O ATP	☐ Flight Instructor ☐ Multiengine ☐ Instrument ☐ Flight Engineer ☐ Other: _____	O FPL O Developmental radar _____ yrs non-radar _____ yrs supervisory _____ yrs military _____ yrs

AIRSPACE		CONDITIONS / WEATHER ELEMENTS			LIGHT / VISIBILITY		ATC / ADVISORY SVC.	
☐ Class A	☐ Class E	O VMC	☐ fog	☐ snow	O dawn	O night	O Ramp	O Center
☐ Class B	☐ Class G	O IMC	☐ hail	☐ thunderstorm	O daylight	O dusk	O Ground	O FSS
☐ Class C	☐ Special Use	O Mixed	☐ haze/smoke	☐ turbulence	Ceiling _____ feet		O Tower	O UNICOM
☐ Class D	☐ TFR	O Marginal	☐ icing	☐ windshear	Visibility _____ miles		O TRACON	O CTAF
			☐ rain	☐ other: _____	RVR _____ feet		ATC Facility Name: _____	

	AIRCRAFT 1			AIRCRAFT 2		
	Your Aircraft Type (Make/Model) (e.g. B737) NOT "N #", Flt #, etc.: _____		Operating FAR Part: _____	Other Aircraft: _____		Operating FAR Part: _____
Operator	☐ air carrier ☐ air taxi ☐ corporate	☐ fractional ☐ FBO ☐ government	☐ military ☐ personal ☐ other: _____	☐ air carrier ☐ air taxi ☐ corporate	☐ fractional ☐ FBO ☐ government	☐ military ☐ personal ☐ other: _____
Mission	☐ passenger ☐ personal	☐ cargo/freight ☐ training	☐ ferry ☐ other: _____	☐ passenger ☐ personal	☐ cargo/freight ☐ training	☐ ferry ☐ other: _____
Flight Plan	☐ VFR ☐ IFR	☐ SVFR ☐ DVFR	☐ none	☐ VFR ☐ IFR	☐ SVFR ☐ DVFR	☐ none
Flight Phase	☐ taxi ☐ parked ☐ takeoff ☐ initial climb	☐ climb ☐ cruise ☐ descent ☐ initial approach	☐ final approach ☐ missed/GAR ☐ landing ☐ other: _____	☐ taxi ☐ parked ☐ takeoff ☐ initial climb	☐ climb ☐ cruise ☐ descent ☐ initial approach	☐ final approach ☐ missed/GAR ☐ landing ☐ other: _____
Route in Use	☐ airway (ID): _____ ☐ direct ☐ SID (ID): _____	☐ STAR (ID): _____ ☐ oceanic ☐ vectors	☐ visual approach ☐ none ☐ other: _____	☐ airway (ID): _____ ☐ direct ☐ SID (ID): _____	☐ STAR (ID): _____ ☐ oceanic ☐ vectors	☐ visual approach ☐ none ☐ other: _____

If more than two aircraft were involved, please describe the additional aircraft in the "Describe Event/Situation" section.

LOCATION	CONFLICTS
Altitude: _____ (single value) O MSL O AGL	Estimated miss distance in feet: horiz _____ vert _____
Distance: _____ and/or Radial (bearing): _____ from:	Was evasive action taken? O Yes O No
O Airport _____ O ATC Fac _____	Was TCAS a factor? O TA O RA O No
O Intersection _____ O NAVAID _____	Did terrain warning system activate? O Yes O No

NASA ARC 277B (May 2009) **GENERAL FORM** Page 1 of 3

Source: `asrs.arc.nasa.gov/docs/general.pdf`

RISK ENGINEERING

Sample reporting form used by the *Aviation Safety Reporting System* run by NASA for the US FAA, for incidents in civil aviation

Page 2: free-form description of the event, of contributing factors, of possible corrective actions

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AVIATION SAFETY REPORTING SYSTEM

NASA has established an Aviation Safety Reporting System (ASRS) to identify issues in the aviation system which need to be addressed. The program of which this system is a part is described in detail in FAA Advisory Circular 00-46E and FAA Handbook 7210.3. Your assistance in informing us about such issues is essential to the success of the program. Please fill out this form as completely as possible, enclose in a sealed envelope, affix proper postage, and send it directly to us.

The information you provide on the identity strip will be used only if NASA determines that it is necessary to contact you for further information. THIS IDENTITY STRIP WILL BE RETURNED DIRECTLY TO YOU. The return of the identity strip assures your anonymity.

Section 91.25 of the Federal Aviation Regulations (14 CFR 91.25) prohibits reports filed with NASA from being used for FAA enforcement purposes. This report will not be made available to the FAA for civil penalty or certificate actions for violations of the Federal Air Regulations. Your identity strip, stamped by NASA, is proof that you have submitted a report to the Aviation Safety Reporting System. We can only return the strip to you, however, if you have provided a mailing address. Equally important, we can often obtain additional useful information if our safety analysts can talk with you directly by telephone. For this reason, we have requested telephone numbers where we may reach you.

Thank you for your contribution to aviation safety.

NOTE: AIRCRAFT ACCIDENTS SHOULD NOT BE REPORTED ON THIS FORM. SUCH EVENTS SHOULD BE FILED WITH THE NATIONAL TRANSPORTATION SAFETY BOARD AS REQUIRED BY NTSB Regulation 830.5 (49CFR830.5).

If you want to mail this form, please fold both pages (and additional pages if required), enclose in a sealed, stamped envelope, and mail to:

NASA AVIATION SAFETY REPORTING SYSTEM
POST OFFICE BOX 189
MOFFETT FIELD, CALIFORNIA 94035-0189

DESCRIBE EVENT/SITUATION

Keeping in mind the topics shown below, discuss those which you feel are relevant and anything else you think is important. Include what you believe really caused the problem, and what can be done to prevent a recurrence, or correct the situation. (USE ADDITIONAL PAPER IF NEEDED)

CHAIN OF EVENTS
- How the problem arose
- How it was discovered
- Contributing factors
- Corrective actions

Page 2 of 3

HUMAN PERFORMANCE CONSIDERATIONS
- Perceptions, judgments, decisions
- Actions or inactions
- Factors affecting the quality of human performance

NASA ARC 277B (May 2009)

Source: `asrs.arc.nasa.gov/docs/general.pdf`

RISK ENGINEERING

Implementation at the corporate level

- Consolidate reported data into indicators on a monthly basis (often automated)
- Indicator results and analysis discussed at executive committee meetings
- Publish a “safety bulletin” which is disseminated to industrial sites
  - displayed on noticeboards on industrial sites, distributed by email…
- When an accident occurs, prepare and disseminate a safety flash on the causes and lessons learned
  - for accidents within your group
  - for accidents from other firms in the same industry sector
- Statistical analysis to identify **weak signals** that could suggest a dangerous trend
- Based on the learning resulting from experience feedback:
  - improve operating procedures, design standards, organization of safety management
  - influence allocation of safety investments

History of the process

- Operating experience feedback as a formalized process was born in aviation
  - *US Air Commerce Act* (1926): regulatory obligation to investigate accidents and incidents
  - *Aviation Safety Reporting System*, managed since 1975 by FAA & NASA
- Important procedure in the **nuclear power** sector since ≈ 1960
- Process required by the European Seveso II regulation for hazardous establishments (1996)
  - top tier sites must implement a Safety Management System (including OEF)
- Process which is becoming common in the health care sector since 2000

A process which has multiple objectives

Learn from errors	Generate reliability data
Feed into safety indicators	Strengthen the safety culture

A process which has multiple objectives

Learn from errors	Generate reliability data
Feed into safety indicators	Strengthen the safety culture

⚠ *These objectives are not perfectly synergistic…*

Objective 1: learn from failures/errors

- ▷ *Errare humanum est, sed perseverare diabolicum*
  - to err is human, but to persevere down the wrong path is diabolical
  - aim to identify anomalies and errors and correct them as soon as possible
  - feed into people's **sensemaking** process to improve their awareness of hazards
- ▷ Learning from your own mistakes is a natural way of learning
  - learning from the mistakes of *others* is more difficult
  - learning collectively (at the organizational level) is harder than at the individual level

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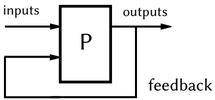

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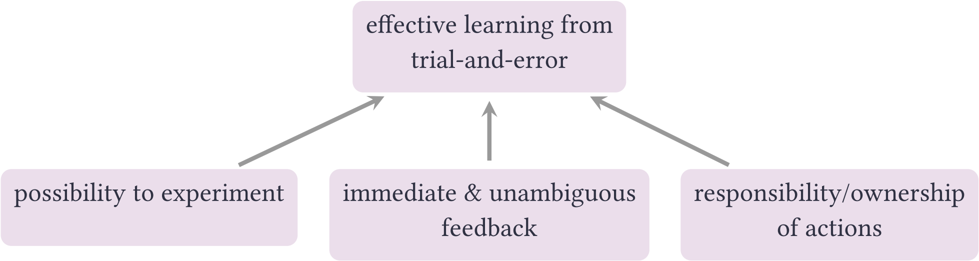
> An OEF process which is designed purely around a rigid vision of safety as the absence of deviations from procedure is far from the reality of complex systems

Limits to the trial-and-error analogy



Limits to the trial-and-error analogy

effective learning from trial-and-error

~~possibility to experiment~~

immediate & unambiguous feedback

responsibility/ownership of actions

Can't experiment with loss of life!

Limits to the trial-and-error analogy

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Accidents are very rare

Incidents not always representative of situations that lead to accidents

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~~immediate & unambiguous feedback~~

~~responsibility/ownership of actions~~

Can't experiment with loss of life!

Accidents are very rare

Incidents not always representative of situations that lead to accidents

Difficult to learn from other people's mistakes

RISK ENGINEERING

Objective 2: produce reliability data

- Operation of complex systems generates data on
  - failure modes
  - initiating event frequencies
  - availability and effectiveness of preventive and protective barriers
- Objectives:
  - improve the **level of confidence** in the **quantitative reliability data** which is used in risk analysis
  - improve the exhaustivity of the identification of accident scenarios
- Large **databases** + **statistical analyses**

RISK ENGINEERING

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> An OEF process that only handles technical issues will miss all the organizational and human aspects of system safety

Illustration: event database at French national railway operator

The locomotive division of SNCF maintains a database of undesirable events called Cecile

- created in 1980
- includes an official classification of reportable events
- 500 to 600 events reported per day
- 2 500 users of the database at the national level
- statistics are generated at the national, regional and site level
- allows analysis of correlations according to event type, severity, location, hour of the day, level of experience of the driver, driver's work hours and shift

Source: *Le Retour d'Expérience à la SNCF*, Mortureux & Tea, Revue générale des chemins de fer, mars 2010

Objective 3: produce safety indicators

- Change in recruitment of managers: from people rising through the ranks to university graduates in management
  - less intimate knowledge of the real working of complex socio-technical systems
- Need to feed into **performance indicators** and management dashboards
  - allow safety level to be followed in a quantitative manner
  - use objective data to identify possible sources of improvement
- Need to design the OEF system as an **information system**
  - not only as a management process

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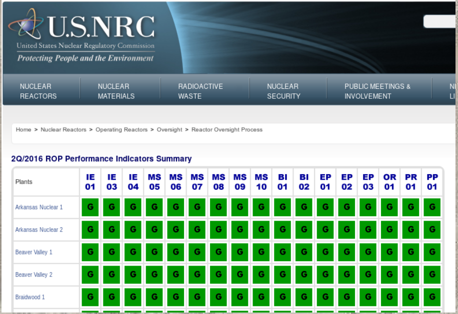
> An OEF system that only meets the strategic goals of management can lead to decreased engagement of sharp-end workers over time

RISK ENGINEERING

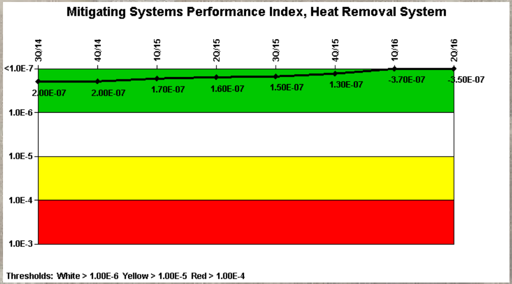
Illustration: indicators used by US NRC

- US *Nuclear Regulatory Commission*: regulator for nuclear power plants in the USA
- Control activity based on audits and on following safety performance indicators (which are made public)



2Q/2016 ROP Performance Indicators Summary

Plants	IE 01	IE 03	IE 04	MS 05	MS 06	MS 07	MS 08	MS 09	MS 10	BI 01	BI 02	EP 01	EP 02	EP 03	OR 01	PR 01	PP 01
Arkansas Nuclear 1	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Arkansas Nuclear 2	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Beaver Valley 1	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Beaver Valley 2	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Braidwood 1	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G



Objective 4: strengthen the safety culture

- OEF is a useful conduit for **discussion on safety issues**
  - bridging different hierarchical levels
  - bridging different trades and professions
  - between company personnel and contractors
- Helps to improve people's **awareness** of hazards and risks
  - keep risks "in sight and in mind"
  - avoid the complacency that can develop over decades of operation without a serious mishap
- Some companies use "fake" accidents which combine the characteristics of several real incidents, to improve learning potential

RISK ENGINEERING

Illustration: US CSB safety videos

- US Chemical Safety and Hazard Investigation Board, federal agency based in Washington DC
  - undertakes root cause investigations of chemical accidents at fixed industrial facilities
  - Web: `csb.gov`
- Publish pedagogical videos to disseminate the results of their investigations
  - 4 million views on their YouTube channel (June 2015)
  - also distributed in DVD format

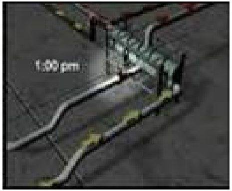
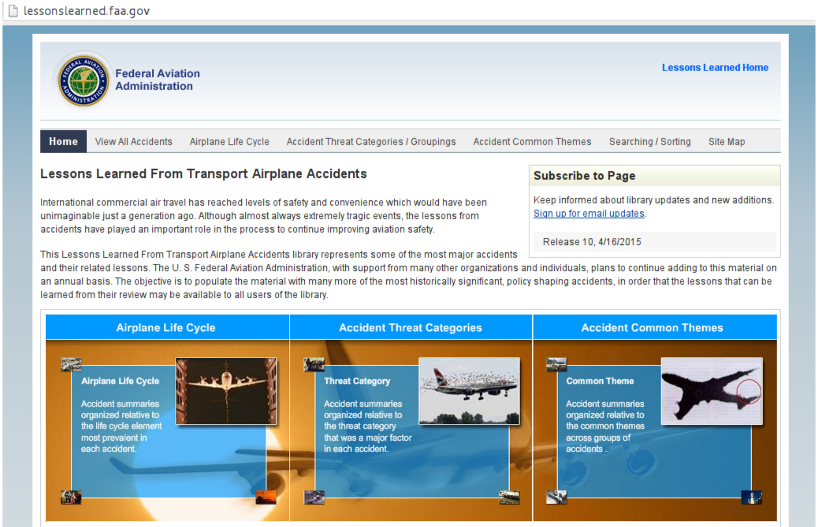


Illustration: US FAA lessons learned site



Source: `lessonslearned.faa.gov`

Illustration: database of hydrogen accidents

Ti-doped Sodium Alanat...

https://h2tools.org/lessons/ti-doped-sodium-alanat

HYDROGEN TOOLS

LOG IN

WORKSPACES RESOURCES FORUMS PARTNERS ABOUT

Home » Lessons Learned Home » Ti-doped Sodium Alanate Incident

Ti-doped Sodium Alanate Incident

Severity:	Leak:	Ignition:
Incident	Yes	Yes

An incident occurred when Ti-doped sodium alanate was exposed to air, apparently resulting in an unstable compound that experienced a rapid exothermic reaction.

The sample consisted of mechanically milled NaAlH4 with 4% TiCl3 dopant which was prepared in an argon atmosphere. The sample was sealed and placed in the probe head of an NMR magic angle-spinning (MAS) rotor and spun at approximately 9,000-13,000 rpm. During the process, the sealing cap dislodged and exposed the sample to ambient air for a little less than 24 hours. When discovered, the sample was visually inspected and showed no evidence of oxidation. The sample was re-capped and returned to an argon environment for removal. Most of the sample material was removed using a small stainless steel needle, but a residual amount, roughly 25 mg sodium alanate, proceeded to undergo a rapid exothermic reaction. No damage resulted to the tube, the glove box or the scientist.

The lab does not know the composition of the material after exposure to the ambient air nor the ignition energy needed to initiate the reaction. However, it appeared that this material underwent a rapid exothermic reaction requiring very little ignition energy.

Aside from exposing this safety hazard, and the relatively minor incident, laboratory personnel pointed out the advantage of working with small samples.

Source: h2tools.org/lessons

RISK ENGINEERING

Links between OEF and safety culture

Informed culture

System managers and operators have current knowledge about the human, technical, organizational and environmental factors that influence system safety.

Culture of flexibility

Organization is able to reconfigure in the face of high tempo operations or certain kinds of hazards, often shifting from the conventional hierarchical mode to a flatter mode.

Reporting culture

An organizational climate in which people are prepared to report safety lapses and potential safety hazards.

Just culture

An atmosphere of trust in which people are encouraged (even rewarded) for providing essential safety-related information, but in which they are also clear about where the line must be drawn between and acceptable and unacceptable behaviour.

Learning culture

Organization possess the willingness and the competence to draw the right conclusions from its safety information system and the will to address problems identified through the reporting system, and possibly implement major reforms.

Figure adapted from *Managing the risks of organisational accidents*, J. Reason, Ashgate, 1997

RISK ENGINEERING

Links between learning and safety culture

- Safety culture can be seen as
  - one of the key “storages” for lessons learned
  - an important mechanism for transferring these lessons to new members of the organization
- Some “safety culture” programmes sold by consultants focus on canned “leadership in safety” messages for managers
- A more research-based viewpoint on safety culture examines the **reality** of **work and decisions in the field**
  - *theory-in-use* rather than *espoused theory*

implicit in our attitudes and actual behaviour

what people say they do, or what they tell others to do

RISK ENGINEERING

Lack of authenticity tends to be detected by workers very quickly, and damages the credibility of all management messages.

Links between OEF and HRO principles

Highly reliable organization

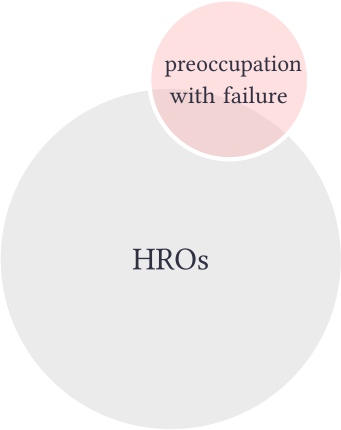
HRO: an organization that manages to avoid catastrophes in an environment where normal accidents can be expected (hazards, complexity).

Body of research on system safety developed in the 1980s by a group of researchers at the University of California at Berkeley.

Five characteristics of HROS have been identified as responsible for the "mindfulness" that keeps them working well when facing unexpected situations.

Source: Weick & Sutcliffe (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*

Links between OEF and HRO principles

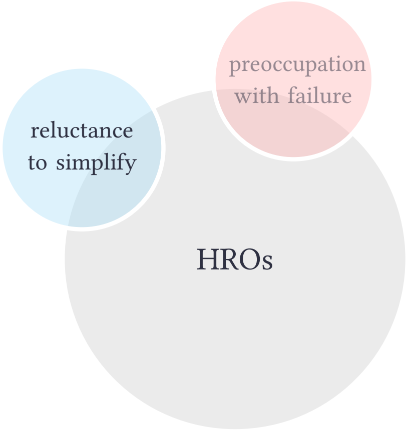


Preoccupation with failure

Active effort to learn from mishaps, near-misses, incidents and accidents. To enable this kind of organizational learning, structures or functions to report relevant events exist and are used. Relevant events are analyzed, integrating the knowledge and experience of people working at the "sharp end".

Source: Weick & Sutcliffe (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*

Links between OEF and HRO principles



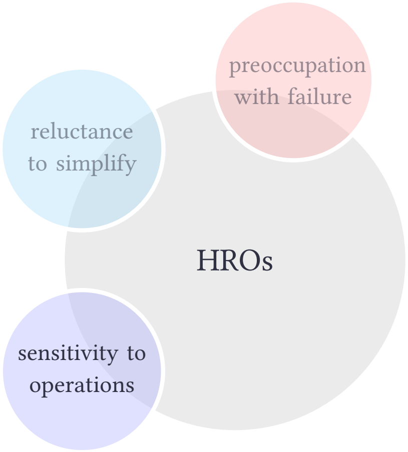
Reluctance to simplify

People within the organization recognize that it operates in a complex, unstable and partly unpredictable world. They reject overly simple models and question the assumption that past successes will necessarily lead to future success.

Source: Weick & Sutcliffe (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*

RiSK ENGINEERING

Links between OEF and HRO principles



Sensitivity to operations

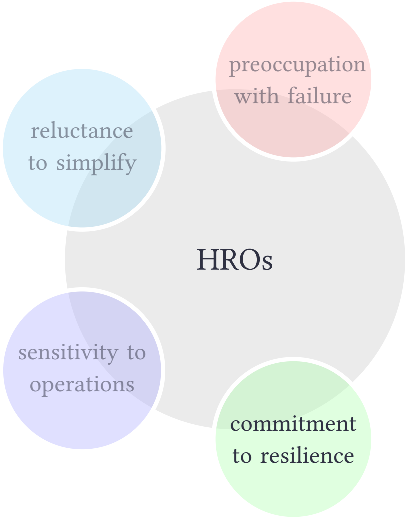
Ability to obtain and maintain the big picture of operations and anticipate possible failures. HROs consult front-line staff in order to build a realistic picture of the status of operations and safety concerns within the organization.

Organizational learning takes into consideration the way in which work is really done in the field.

Source: Weick & Sutcliffe (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*

RISK ENGINEERING

Links between OEF and HRO principles



Commitment to resilience

HROS develop an ability to cope with and bounce back from errors and unexpected events. The essence of resilience is the ability to maintain or regain a stable state, which allows the organization to continue operations after a major problem or during continuous stress. Organizations must be sensitive to warning signs, which may be signaled through the OEF system.

Source: Weick & Sutcliffe (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*

Links between OEF and HRO principles

Deference to expertise during emergencies

Decision-making is hierarchical during routine operations, with clear allocation of responsibilities. In emergencies, decision-making moves to individuals with expertise, irrespective of their hierarchical position.

HROS value diversity since it helps them to notice more and to act properly. In the context of rigid hierarchies, errors at higher levels tend to couple with errors at lower levels, making the problem more difficult to understand and more prone to escalation.

Source: Weick & Sutcliffe (2001). *Managing the Unexpected: Assuring High Performance in an Age of Complexity*

What is learning?

What is learning?

- Some possible definitions:
  - knowledge or skill acquired by instruction or study
  - modification of a behavioral tendency by experience
  - responding to experience by modifying technologies, forms and practices
- Learning is a significant source of **competitive advantage** for a firm
  - in a dynamic world, performance cannot be sustained over time without learning
- Learning is a source of **increased safety**
  - better trained individuals produce fewer surprises (reduced variability)
  - organizations use rules, procedures and standard practices to ensure learning is transferred from old to new members ("routinization")

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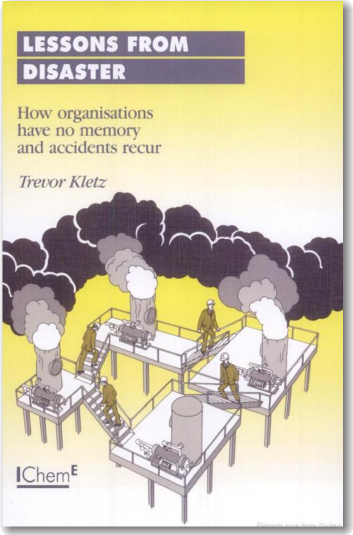
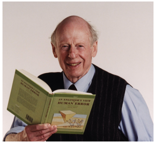
What does it mean for an organization to learn?

Learning is often thought of as a process which only occurs within individuals' brains.

> *Organizations have no memory. Only people have memory and they move on.*
>
> *— Trevor Kletz*





Organizational knowledge

- Most organizational scholars disagree with T. Kletz's statement on absence of organizational memory
- Learning can be embedded within:
  - organizational beliefs and assumptions: culturally accepted worldviews about the system
    - what hazards are present, what risks are important, what is normal, what is taken for granted, what should be ignored
  - organizational routines, procedures and regulations (precautionary norms)
  - organizational structure and relationships
  - the design of equipment and implementation of technologies
  - the knowledge of people working within or interacting with the system

Learning and change

- People sometimes assume that learning has occurred once an event has been analyzed and lessons have been drawn
- Learning cannot be reduced to simply making a piece of information available to somebody
  - go beyond the “hydraulic” model of learning (the educator pours knowledge into the empty brains of the students)
- Learning also requires:
  - someone to internalize the new knowledge and “translate” it to their context
  - some form of change, in system design, in organizational structure, in behaviour…
- If new behaviours are not accompanied by new understandings, then learning cannot be robust and sustainable across time and ever-changing circumstances

Image: the “Nuremberg funnel”, postage stamp circa 1902, via Wikipedia

Learning from catastrophes, incidents and anomalies

Learning potential is present in:

- **Catastrophes** and large accidents
  - instrument for learning: accident investigation
  - pressure to investigate, because of (incorrect) assumption that "a big accident can only have been caused by a big mistake"
  - significant resources available to implement change
  - few events (luckily!) from which to learn

When your investigation report is spattered with blood, implementing changes becomes easy…

- **Incidents**: analyze unwanted events, deviations from procedure, accident precursors, near misses in a systematic manner
  - instrument for learning: operational experience feedback, or lessons learned system
  - a larger number of events of this type is available for analysis
- **Anomalies**: minor deviations and quality-control issues, often recorded automatically by online monitoring equipment.
  - instrument for learning: statistical analyses of event databases, or quality analyses

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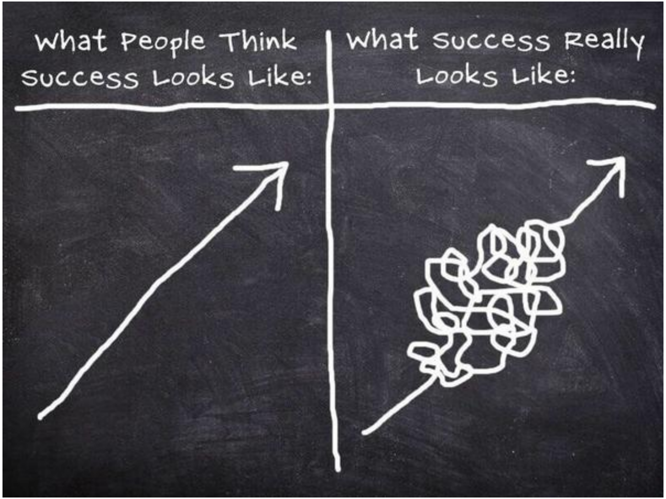
Learning from both success and failure

- Learn from **what when wrong**:
  - search for underlying failures
  - attempt to eliminate their causes and improve safety barriers
  - safety seen as resulting from a reduction in the number of adverse events
- Learn from **what went right**:
  - study normal operations and the ways in which workers cope with varying performance requirements
  - develop a better understanding of system features that contribute to resilience
  - safety seen as the result of the ability to succeed despite varying performance demands and environmental variability
  - *cf.* research on “High Reliability Organizations” and “Resilience engineering”

These two sources are complementary

What is success?

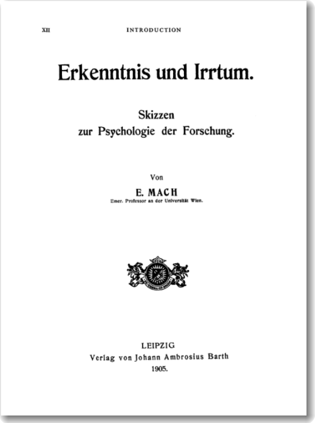


There may be more to learn from normal operation than meets the eye!

Knowledge and error

> *Knowledge and error flow from the same source, only success can tell the one from the other.*
>
> *— Ernst Mach*

(Duality of expertise and error)



XII INTRODUCTION

Erkenntnis und Irrtum.

Skizzen
zur Psychologie der Forschung.

Von
E. MACH
Emer. Professor an der Universität Wien.

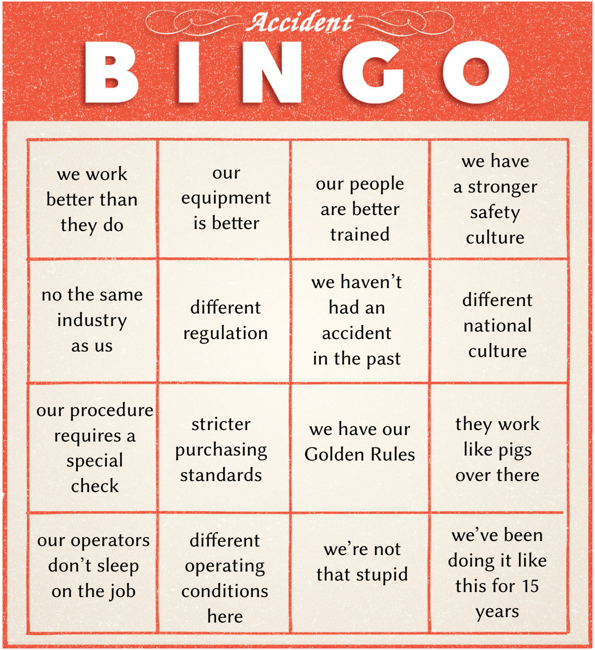
LEIPZIG
Verlag von Johann Ambrosius Barth
1905.

Source: *Knowledge and Error: Sketches on the Psychology of Enquiry*, E. Mach, 1905

Learning from others

- Learning from others is more difficult than learning from one's own mistakes
  - "we do things differently (better)", so wouldn't have been affected by that accident
  - "we aren't concerned by that way of working"

It wouldn’t happen to us...



- An attitude of **denial** is common after accidents

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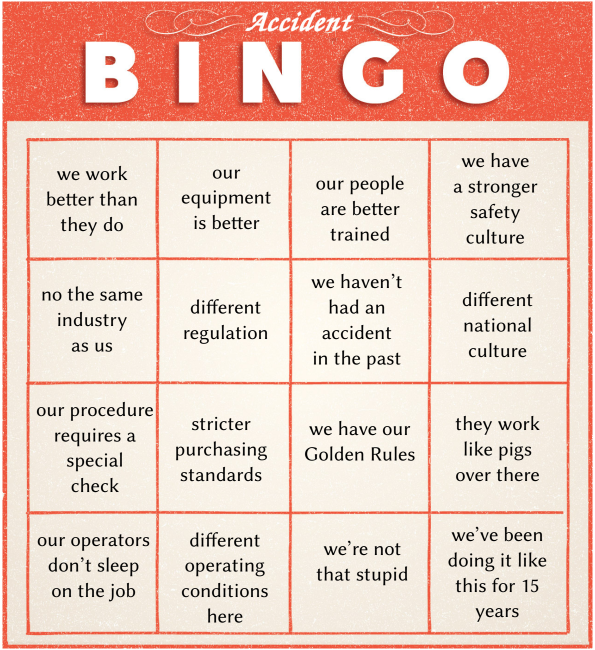

- An attitude of **denial** is common after accidents
- Denial is contrary to the *preoccupation with failure* encouraged by HRO researchers

More information: Distancing through differencing: an obstacle to organizational learning following accidents, R. Cook and D. Woods, 2006

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Incremental learning

Adjust your actions to reduce the gap between desired and actual results

Practice, feedback, improvement

Underlying paradigm is that of control: increase predictability, minimize variations, avoid surprises

Transformational learning

Change in perspective, defiance of complacency, conformity and norms

Increases variation to explore new opportunities

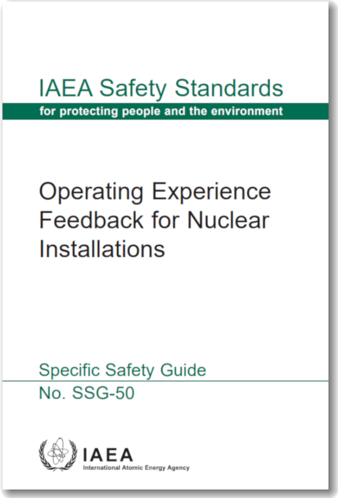
Is less smooth and more infrequent

Threatens established control mechanisms and existing bureaucratic mechanisms

A natural tension exists between these two types of learning, somewhat related to the anticipation/resilience tradeoff described by [Wildavsky 1998]

> *It should not be necessary for each generation to rediscover principles of process safety which the generation before discovered. We must learn from the experience of others rather than learn the hard way. We must pass on to the next generation a record of what we have learned.*
>
> *— Jesse C. Ducommun*

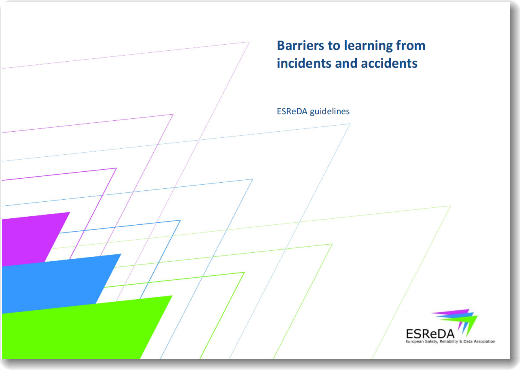
Further reading



IAEA Specific Safety Guide SSG-50

Freely available from `iaea.org/publications/`

Further reading



ESReDA guidelines document *Barriers to learning from incidents and accidents* (2015)

Freely available from

`esreda.org/wp-content/uploads/2016/03/ESReDA-barriers-learning-accidents-1.pdf`

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Further reading

- *Learning from incidents and accidents* entry in OSHwiki, at `oshwiki.eu/wiki/Learning_from_incidents_and_accidents`
- Article *Organizational learning activities in high-hazard industries: the logics underlying self-analysis*, John S. Carroll, *Journal of Management Studies*, 1998:35(6), DOI: 10.1111/1467-6486.00116
- Book *Prevention of Accidents Through Experience Feedback* by Urban Kjellen, CRC Press, 2000, ISBN: 978-0748409259 (464 pages)

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