Accidents and Human Factors: Introduction to the Main Themes

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Overview

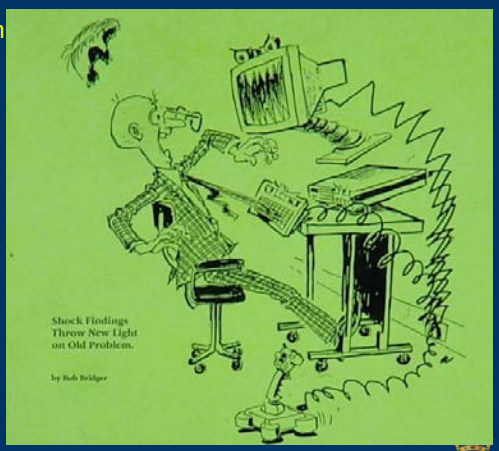
- Human behaviour always occurs in a context
- If we want to understand why people behave as they do at work….
- We have to understand the context in which they work

Performance Shaping Factors

- The context is nothing more than the sum of PSFs in workplace at the time the accident took place
- Good ‘detective work’ may be needed to identify the PSFs
- PSFs are not causes – but they are always relevant
- We can learn from them and improve the work environment

Human Factors Focus

- The focus of Human Factors is on the interactions between users and technology
- ‘Systems’ always have a human element, no matter how automated they are
- Accident investigators should focus not only on what people were doing, but the equipment they were using and the overall context, including the workload



Sources of Risk in Complex systems

- Hardware – normally low risk
- People – often get the blame
- Interfaces:
  - New components incompatible with old ones.
  - Old components incompatible with new ones.
  - Some components not compatible with people

	System Crashes?	
Human Error?	Yes	No
Yes	A	B
No	C	D

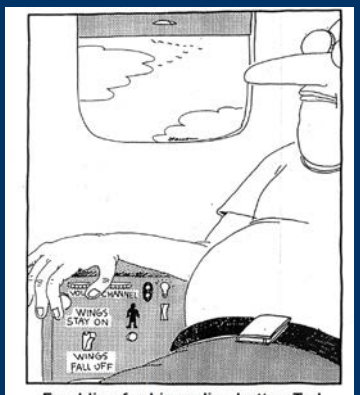
A - Blame the user
B - 'Unknown Unknown'
C - Blame something else
D - Taken for granted

Accidents and Human Error

- Accidents are often attributed to human error
  - "90% of accidents are due to human error"
- But humans make errors all the time and normally nothing happens
- In well-designed systems, there are barriers to stop 'human error' leaking into the rest of the system:
  - Failsafe operation – human error causes the system to fail but nobody gets hurt
  - Failsoft operation – system fails slowly, gives cues that something is wrong so operators have time to prevent a disaster
- 'Latent' hazards that prompt mistakes

Latent Hazards

the foundation of an accident may be laid years before….



Fumbling for his recline button Ted unwittingly instigates a disaster

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Two Steps to Thinking About Human Factors in Accident Investigation

- Micro-ergonomic PSFs
  - Focus on immediate events during a thin slice of time at the critical moment. Search for PSFs for human error in the immediate environment and search for latent hazards.

- Macro-ergonomic PSFs
  - Focus on the organisation and the events leading up to the accident. Seek to discover *why* the PSFs were present in the environment. It sees the accident as a process – the end result of an accident 'trajectory' in which safety systems failed one after the other.

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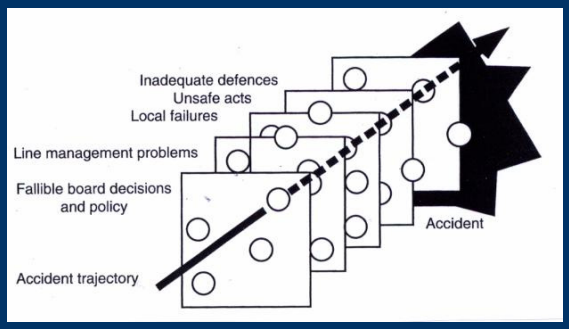
Traditional view of safety

- Safety is a failure problem- a chain of directly related events
- Establish barriers/prevent individual component failures then accidents won't happen
- Human error is the cause of accidents
- Blame/re-train/remove (automate)/add more rules and procedures
- If we all obey the rules, we'll always be safe, won't we?



Problems in Conceptions of Human Reliability and Human Error

- Erroneous assumption that Human Error is rare
- Simplistic ideas about cause and effect
- Just because the driver was drunk at the time of the accident, doesn't mean the car or the road were safe

Traditional view of safety

- Does not take into account:
  - Complex systems –too complex to anticipate all possible interactions
  - New technology, changing roles –are systems static through their lifespan? NO
  - Culture and management (positive or negative effects)

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New View on Safety: Systems Approach

- All behaviour occurs in a context (system)
- All complex systems are dangerous
- People create safety through daily practice at all levels – safe organisations have a strong safety culture
- Major accidents often result from a slow migration of the entire system toward a state of high-risk
- Pointless to tell people not to make mistakes. More useful to reinforce safe practices and desirable behaviours
- Operators may be at the mercy of the systems they run

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At the Mercy of the System

- Automation is better than the operator but the operator is supposed to know when it is working properly
- The operator has to take over when the automation fails
- Operators of badly automated systems will get more practice than those of well-automated systems

Risk Homeostasis Theory and Incentives for Unsafe Behaviour

- Standard operating procedures?
- If people don't follow SoP's what questions should we ask?
- What's wrong with the people?
- Or……
- What's wrong with the SoPs?

RHT and Accidents

- Risk homeostasis theory was developed in the context of accident investigation
- It challenges the assumption that when we make one part of a system safer the number of accidents will drop
- RHT holds that people have a target level of risk that they are comfortable with. If there is a discrepancy between the target level of risk and their perceived level, they modify their behaviour accordingly
- What seem to be ‘violations’ are, to personnel, simply normal behaviours within their own ‘comfort zone’

Risk Compensation

- Risk compensation is a behavioural mechanism that can only affect safety under certain conditions
  - The operator or user has sufficient control over his behaviour to make a difference
  - The operator or user receives feedback from the environment to enable a level of risk to be perceived
- Behavioural adaptation may lead to the opposite of the required effect in a safety intervention!
- People ‘consume’ the added safety by taking more risks!

Evidence

- According to RHT, many safety features in car design and traffic management, including legislation have no effect on accident fatality rates
- Compulsory seat belt wearing, air bags and crash helmets for motorcyclists and better roads only cause people to ‘consume’ the added safety by driving faster
- Per capita road fatality rates haven’t changed in 100 years
- Deaths per mile travelled have dropped dramatically
- People travel more and faster

Implications

- Accidents often happen when we think we are safe
- Design so that people have an accurate perception of the true risk of accidents happening as well as the consequences – improve risk perception
- Consider the costs and benefits of engaging in safe and unsafe behaviour for the user
- If necessary increase the rewards for safe behaviour and the penalties for unsafe behaviour
- What PSFs might incentivise an unsafe act?

Accident Case Study No 1: Herald of Free Enterprise

Background

- Ferry was designed for the Dover-Calais route with double linkspans at both ports
- Vehicles could be loaded simultaneously onto G and E/F vehicle decks through vertically hinged watertight doors
- The bow doors could not be seen from the Bridge

On the Day of the Accident

- Free Enterprise was at Zeebrugge in Belgium. She had not been designed for this port
- Only one ramp for loading vehicles
- To load the higher decks, the bow ballast tanks were filled because the ramp was not high enough to reach E deck
- After all the vehicles had been loaded, the tanks were NOT emptied, meaning the bow was lower in the sea than normal

The Story Unfolds

- The assistant Boatswain was supposed to close the G deck bow doors BEFORE the ship slipped her moorings
- He had, however, gone for a nap after cleaning the deck
- The first officer was supposed to remain on G deck until after the doors had closed but is believed to have been under pressure to get to his station on the Bridge, believing that that the assistant boatswain was on his way
- The boatswain – the last person on G Deck said that he did not close the doors because it was not his duty

The Ferry Leaves Port

- 18:05hrs: Believing that the bow doors had been closed, and unable to see them from the bridge, the Captain gave the order to depart
- The ship had 80 crew, 459 passengers, 80 cars, 3 buses and 47 trucks
- 18:24: The ferry enters the open sea. When the ferry reached 18.9 knots (21.7 mph), water began to enter through the G deck doors. The ferry capsized in 90 seconds
- The electrical and power systems failed immediately, leaving the interior in darkness
- The ferry floundered in shallow water onto a sandbar that prevented her from sinking completely

Immediate Consequences

- Despite immediate attempts at rescue, 189 people died
- The water temperature was 3 degrees Celsius – most drowned after being disabled by immersion in freezing water

Official enquiry

- Three main causes:
  - Failure to close the bow doors
  - Failure to check that they were closed
  - Leaving port with the doors open
- Performance shaping factors:
  - Poor communication at all levels in the hierarchy
  - Failure to empty the ballast tanks prior to departure
  - Time pressure to leave early
  - Hydrodynamic factors
    - Bow wave above 18 knots
    - 'Squat effect' in shallow water
  - Rejection at board level of the proposal to install a warning light on the bridge

Recommendations-preventing recurrence

- Indicator light on bridge
- Drainage flaps to allow water to escape from deck
- Minimum freeboard increased from 76 to 125 cm for all new vessels
- Undivided decks of this length now banned
- New ferries only allow vehicles to enter and exit from the stern

Lack of Safety Culture

- The company did not see itself as operating in a high risk industry
- There was a complete disregard for safety at all levels up to the board
- Ferries had left ports with bow doors open in the past and this had not been reported to Masters
- A suggestion to install a warning light on the bridge had been ridiculed by senior management
  - Comments to an internal memo reflect severe lack of responsibility and safety culture

Accident Case Study no 2: Passenger Ship 'Royal Majesty' Runs Aground near Nantucket Island:

- June 10, 1995, RM departs St. Georges, Bermuda en route to Boston
- Ship's navigator sets autopilot in NAV mode. Checks GPS against ground/radio-based positioning systems (Loran-C). Ground-based system reveals the position about 1 mile southeast of GPS position. OK
- 34 hours after departure, ship runs aground, 17 miles off course
- 30 minutes after departure, the cable from the GPS receiver to the antenna had come loose and the GPS had defaulted to dead reckoning mode

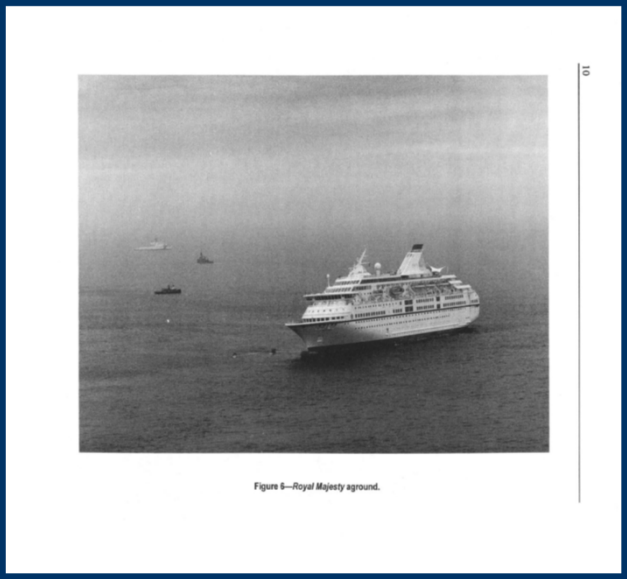

Figure 6—*Royal Majesty* aground.

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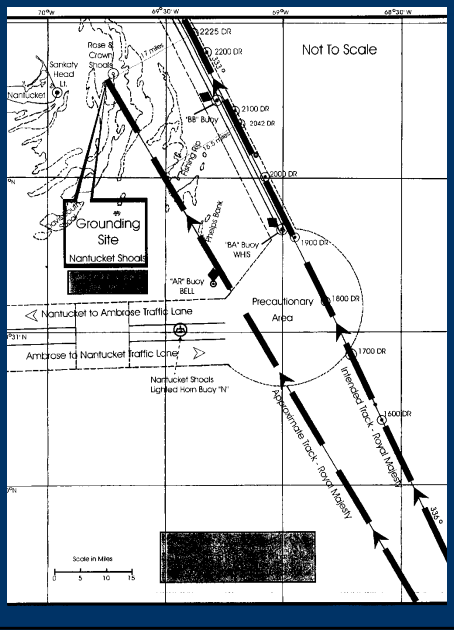

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Extract from the Accident Report

- “Had the officers compared position information from the GPS and the Loran-C they should not have missed the discrepant co-ordinates”
- On approaching land:
- “The second officer’s response to these sightings should have been deliberate and straightforward. He should have been concerned as soon as the buoy was not sighted and when the lookouts sighted the red light….”

Situation Awareness

- Often used as an explanation for accidents but really it is nothing more than ‘pop psychology’ that explains nothing
- Loss of ‘situation awareness’ is nothing more than the difference between what the operators knew at the time and what the investigators know
- Operator situation awareness depends on how ‘*the situation’* is presented to them by the technology and how they have been trained to understand it

Comments

- The report focuses on what the officers *should* have done (easy when you know what's going to happen next):
- Focussing on what the officers did wrong leads to safety initiatives centred on redrafting of instructions, rules and training procedures. This is like saying 'don't make mistakes'
- Hindsight bias focuses our attention on those who were closest in time and space when the accident occurred and leads us to 'cherry-pick' data in order to apportion blame.

Comments

- Accident investigators should try to reconstruct the sequence events from the perspective of those involved at the time
  - Officers were told not to use the Loran-c when at sea but to rely on the ECDIS system
  - In those days, satellite reception was poor and the GPS often went 'off-line-' for short periods. Even if they had heard the 'beep' it was nothing to worry about
  - Many PSFs for error, Many latent hazards
- The really interesting question is why everything seemed OK at the time.

Everything Seemed OK Because….

- There was no clear indication that the system had defaulted to dead reckoning mode
- The GPS display indicated that the ship was on course
- People are insensitive to 7counterfactual evidence when everything seems OK

Accident Proneness

- Accident prone people exist
- But we all become more accident prone when exposed to:
  - Stress
  - Being awake when we are normally asleep or lack of sleep
  - Alcohol
  - Time of day (e.g. early mornings)
  - Bad workplace ergonomics
- Conflicting job demands
- Piecemeal management and constant change

Stress and Minor Accidents
RN Research Findings

- Personnel with psychological strain due to high work demands were 3 times more likely than controls to have had an accident in the years 2007-2010
- Personnel scoring 40 or more on the cognitive failures questionnaire were 4 times more likely than controls to have had an accident
- Accident-prone people exist
- Whether they have an accident or not depends on situational factors
- Why is this?

Mental fatigue in working life

- Exercising self control over the day diminishes the capacity for further acts of self control
- Self-regulatory strength, like muscular strength, is a limited resource that needs to be replenished after use
- Even people who cope well, will need time to recover from demanding work
- To understand and manage stress, we need to understand where the demands on executive resources come from

GHQ-12
General Health Questionnaire

- A commercially available screening tool for measuring anxiety and depression in people
- Used worldwide (available in 38 different languages)
- Counts the number of symptoms in an individual (up to twelve)
- For RN personnel, those with 4 or more symptoms deemed to be strain ‘cases’

Practical exercise: ‘Me now versus me then’

- Complete the GHQ-12 twice
- First time: rate yourself according to how you feel RIGHT NOW
  - Write the number ‘1’ over the answer that corresponds to how you feel NOW
- Second time: recall how you felt at a time in your life when things were going very badly
  - Write the number ‘2’ over the answer that corresponds to how you felt THEN

Accident-Prone People Exist …. But…

- **Having an accident is just another of the adverse reactions to high work demands when you can't cope**
- **Accident investigators should focus on PSFs that drain the attention of personnel**
- **Accidents are more likely when personnel have to deal with conflicting demands on their attention**
- **Avoid doing dangerous things when you're already busy with something else!**
- **Really safe systems should be operable by accident-prone people…**

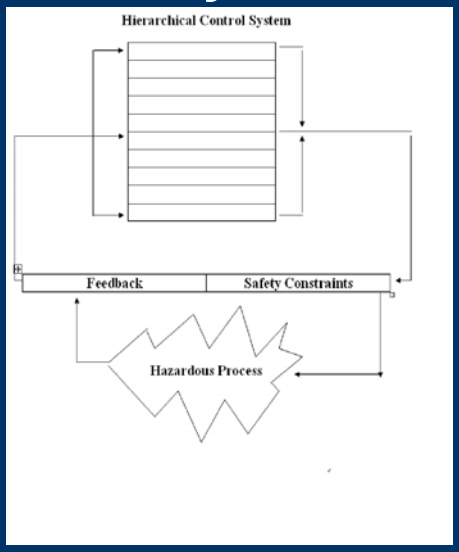
Coping Strategies

Line Manager Skills for Managing Susceptible Individuals When Job Demands are High

- Repeat instructions for critical tasks
- Break high-level instructions into simple orders and insist on clear deadlines, giving feedback as each new order is issued
- Agree on a written list of tasks for the day
- Avoid imposing several tasks at once, particularly if the tasks may conflict
- Provide timely reminders for approaching deadlines
- Make task priorities clear at all times
- Contextualise warnings – e.g. put 'Diesel only' signs on the inside of fuel filler caps
- Be pragmatic – if a work routine does not become familiar in a short time, change it
- Provide checklists and written procedures for critical tasks

What is ‘Safety’?

- Safety is all about controlling what happens next….
- All systems are hazardous
- Human Factors can help to Identify the PSFs and eliminate/ control them



Questions?