A STUDY BOOK FOR THE

NEBOSH NATIONAL DIPLOMA

for Occupational Health and Safety Management Professionals

UNIT 1: HEALTH AND SAFETY PRINCIPLES

SEVENTH EDITION

2.1 - Organisational structures

Concept of the organisation as a system

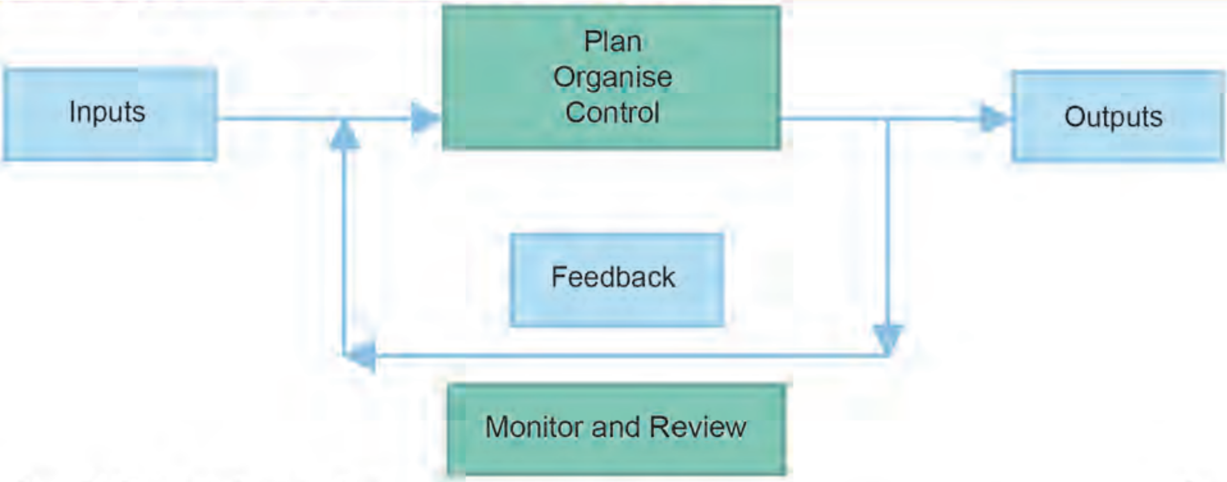

Figure 2-1: The organisation as a system. *Source: RMS.*

As may be seen by the above diagram an organisation may be represented as a system comprising inputs that are processed to provide outputs, with a feedback loop to adjust the process to ensure the correct output is consistently produced. If we overlay the health and safety components on this, we find the following:

Inputs	Includes resources in the form of raw materials, time, money, people in conjunction with goals (derived from moral, legal and economic sources) and information. Routes into the organisation include design and development of structures, equipment and materials, acquisitions, purchase of products and services, and recruitment.
Process	Includes actions related to planning for health and safety, organising, controlling. The process part of the system can be broken down further into planning, organising, controlling of the following three main strategies: 1) Technical measures. 2) Procedural measures. 3) Behavioural measures.
Outputs	Includes planned outputs such as provision of products and services, many resultant by-products (for example, waste) and information for external use. This must be seen in conjunction with the health and safety outputs; negative outputs (if the process is not successful) such as injury accidents, ill-health, fines and positive outputs such as good health, reduced insurance premiums and public respect.
Feedback	Includes monitoring on a short period basis through meetings and inspections, longer term such as accident investigation or audits and review of general/specific actions of the process.

The most common application of systems in health and safety is the management system. Where the various components, for example policy, planning, review etc, are linked so that the management system's components interact and relate to each other.

Organisation structures and functions

The effective functioning of an organisation is dependent on a number of factors:

- Type of organisation - formal or informal.
- Members of the organisation understand the goals.
- Members of the organisation identify positively with the goals.
- Members know what their role and function is in the organisation.
- Members are competent (and confident) to fulfil their role and function.
- Members communicate effectively.
- Members co-operate to reach the goals.
- The organisation controls the actions of members in order to maintain direction towards the goals.

FORMAL

The most common formal structure is hierarchical, with authority being dispersed through the lines of the organisation that separate into different roles and then 'down' through the structure to the members of the organisation that carry out specific tasks. Formal structure does not establish a style of organisational working, this is established by the culture and may be autocratic through to democratic. Good examples of a formal structure would be uniformed services, where roles and the authority attached to them are clear.

Aircraft cockpit

Poor design of controls and instruments in aircraft cockpits means that pilots have often made fatal mistakes, such as operating the flaps instead of the undercarriage and misreading altimeters.

A particular example of this occurred in the UK when a passenger aircraft crashed in 1989 killing 47 people.

The pilot reported engine trouble and was diverted to a nearby airport. A fan blade in the left engine had broken and was causing noise, vibration and smoke.

There was confusion about which engine had become faulty, which led the pilot and co-pilot to shut down the right engine, leaving the aircraft to glide. For a period, the smoke from the left engine was reduced and the symptoms appeared to have been corrected.

As more fuel was pumped into the damaged left engine it burst into flames. The aircraft crashed a small distance from the end of the runway.

Figure 2-66: Kegworth air crash. *Source: UK Press Association.*

There were many technical issues that contributed to the crash, one of which related to the design of the aircraft instruments in the cockpit. This version of the aircraft, a Boeing 737, had several modifications compared to previous versions of the aircraft, including changes to the instrument design and layout. In particular, the engine vibration indicators that would have enabled the correct identification of the faulty engine had been changed, making them less obvious and harder to read. At one point during the Kegworth flight, the dial indicating the vibration in the left engine rose to the maximum and stayed there for three minutes, but the pilots failed to see it.

The earlier version of the aircraft had dials with a large, clearly visible mechanical pointer, making it easier to read, ***see figure ref 2-67***, the arrows show the engine vibration indicators.

Figure 2-67: Earlier version of Boeing 737 dials. *Source: UK Air Accidents Investigation Branch.*

Figure 2-68: Dials of later version of Boeing 737. *Source: UK Air Accidents Investigation Branch.*

In the version of the Boeing 737 that was involved in the crash the engine vibration indicators had been made smaller, ***see figure ref 2-68***, and a less defined design of display was used, ***see figure ref 2-69***.

A 'stylish' design was used in the later version of the Boeing 737, it had a thin dotted line moving around the number indicators. Although the engine vibration indicators provided accurate information on the condition of the engines the design meant the information was less obvious to the pilot and co-pilot.

The aviation industry has been the focus of much ergonomics research, because of the ever-increasing mental demands on flight crew. To give some perspective, a 1940s aeroplane typically had 20 instruments, a 1950s jet about 50, a 1960s airliner about 180, and current airliners have around 450.

Figure 2-69: Vibration indicator dials of later version of Boeing 737. *Source: UK Air Accidents Investigation Branch.*

Ergonomics factors are important in the design of aircraft cockpits. The layout and function of cockpit displays and controls are designed to increase pilot situation awareness, without causing information overload. The pilot of an aircraft must be able to easily interface with all the controls. The layout of instruments and controls must be in a logical pattern and emergency controls must be easily activated and, perhaps more critically, not activated

Fault tree

Fault tree analysis (FTA) is a logic-based causal analysis process used to identify and analyse the 'faults' (causes) which led to an incident. The process was developed by Bell Telephone Laboratories for the US Air Force for use with the Minuteman ICBM system to determine the sequence or combinations of events that could lead to an unauthorised launch of the weapon. FTA describes the sequences of faults, for example human failure or equipment malfunctions, by working downwards from the incident (known as the 'top event'). The fault tree is constructed by using logic symbols ('or' gates and 'and' gates) to establish the relationship between the incident and each cause, ***see Figure 5.9***. The 'and' gate illustrates causes that need to combine to have an effect and the 'or' gate illustrates causes that act independently from each other and each could have an effect that could lead to a cause or in turn the incident.

The graphical representation makes it is easy to follow the flow of causes and sub-clauses and indicates where the placement of controls will have maximum impact on the progression from cause to effect.

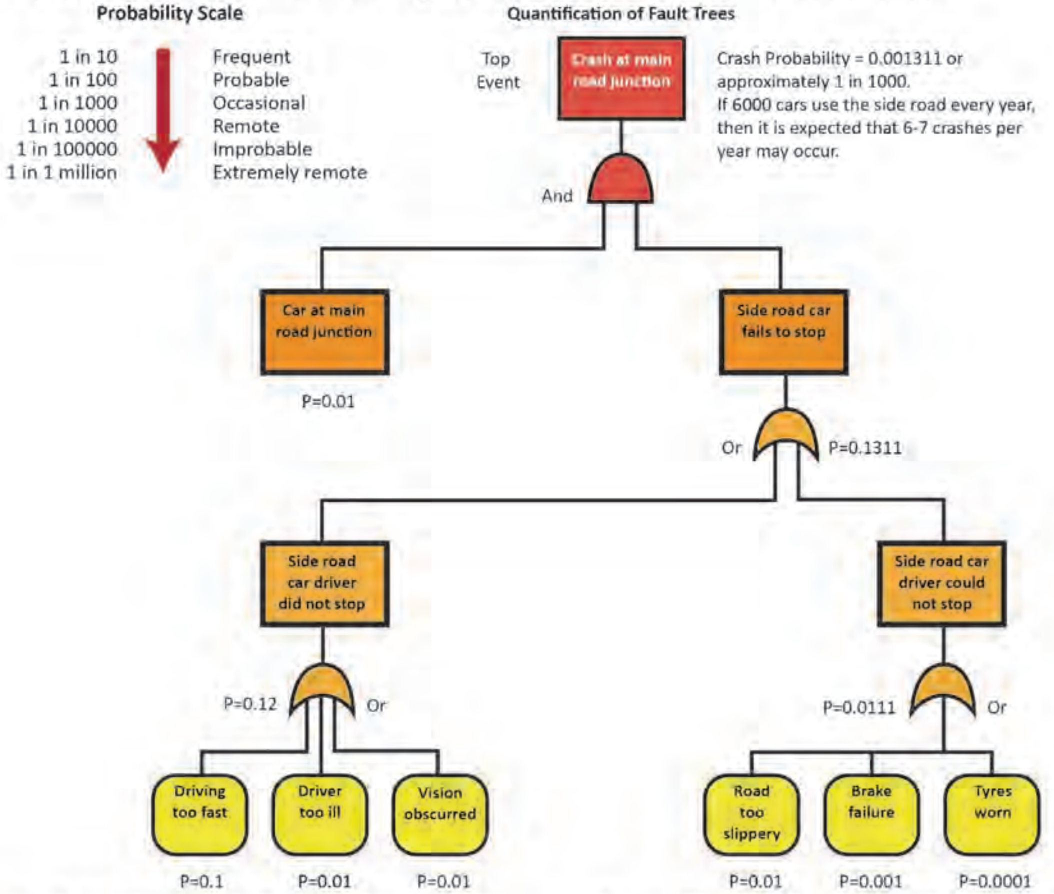

Figure 5-9: Discovery of underlying causes by 'Fault Tree Analysis' (FTA). *Source: HSE HSG65 Successful Health and Safety Management.*

Event tree

Event tree analysis (ETA) is a 'forward thinking' process. That is, the analyst begins with an initiating event and develops the resulting possible events arising from the event and determines if they are likely to lead to subsequent sequences of events that could result in an incident.

ETA was developed in the nuclear industry, initially in the USA and later more widely in the UK nuclear industry in the 1960s.

The analysis of each event considers the likely success or failure of control measures and determines likely pathways to an incident. The analysis is done in binary form, each stage requiring a yes or no, success or failure answer. Event trees provide a methodical way of recording the event sequences and defining the relationships between the initiating event and the subsequent events that combine to result in an incident.

In the example ETA in ***Figure 5-10*** the initiating event, the gas release, is listed on the left-hand side of the event tree and the control measures are listed in a chronological order across the top of the event tree. The horizontal line from the initiating event represents the progression of the incident path from the initiating event up to the first control measure (gas detector).

The ETA evaluates the first control measure for likely success or failure, which is illustrated by a branch point with a vertical line, usually an upward path denotes the success of the control measure and a downward path denotes the failure of the control measure. If the failure of the control measure on its own could lead to the incident this is indicated by the horizontal line from the bottom of the vertical branch line to the incident (point of danger).

5.1 - Loss causation and qualitative analysis of data

Loss causation theories/models, tools and techniques

UNDERSTAND SOME OF THE UNDERLYING PRINCIPLES CONNECTING CAUSES AND OUTCOMES

Incidents with the same cause(s) usually have a range of possible outcomes

Incidents with the same cause(s) can have a ***number of possible outcomes***, depending on the actual circumstances at the time of the incident. The outcomes from some incidents could range from a near miss, with no harm to people, through to minor and serious injuries or possibly death.

This is illustrated by the following example, where an unstable stack of bricks causes a brick to fall from height.

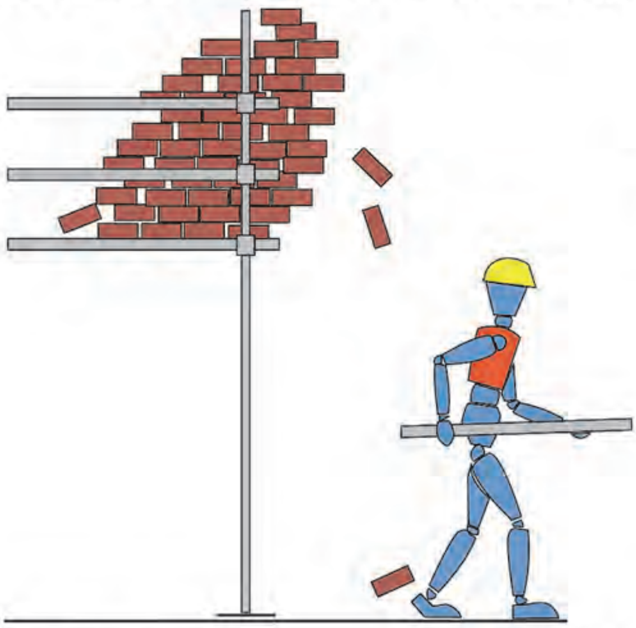

Figure 5-1: Near miss. *Source: HSG245.*

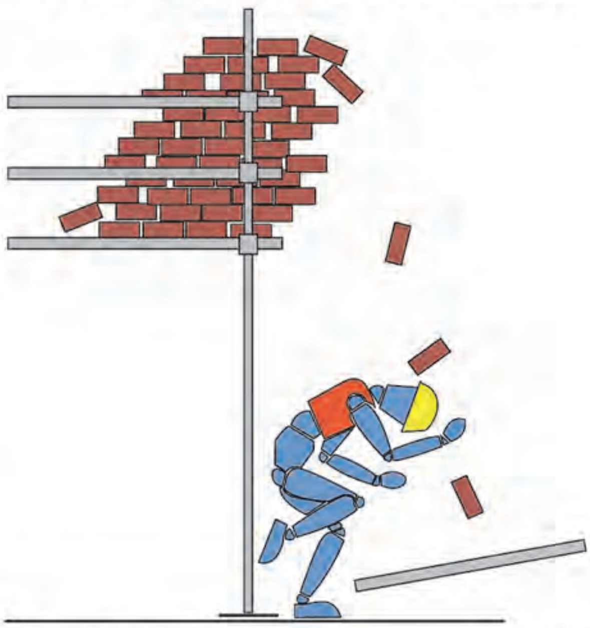

Figure 5-2: Injury. *Source: HSG245.*

The circumstances in this example could result in the following outcomes:

1) The brick falls to the ground near a worker, but there is no injury, the outcome is a near miss.
2) The brick falls and strikes a worker causing a minor injury, for example a cut and bruising to the hand.
3) The brick falls and strikes a worker working directly underneath causing a fatality.

"incident - occurrence arising out of, or in the course of, work that could or does result in injury and ill health (3.18)

Note 1 to entry: An incident where injury and ill health occurs is sometimes referred to as an "accident".

Note 2 to entry: An incident where no injury and ill health occurs but has the potential to do so may be referred to as a "near-miss", "near-hit" or "close call"."

Figure 5-3: Definition of incident. *Source: ISO 45001.*

There is an ***underlying randomness*** to the occurrence of incidents and their outcomes. This makes it difficult to predict when and where incidents will happen and the severity of the outcomes. Whether the outcome of an incident is a near miss, minor injury or death can be a matter of chance. The difference between a near miss and a fatal injury in terms of time and distance can be very small and at the time of the incident the is often little influence on what the outcome is. If no action is taken following incidents that result in no or minor injury severe injury will occur sooner or later if it is left to chance.

Which means that whatever the outcome actually was we should ***consider the potential outcome*** that could have resulted from the incident and identify the cause(s). Although it is important to identify the cause(s) of incidents that actually result in a fatality, from this example, it can be seen that is important to learn and take action following an incident that resulted in a near miss, which had the potential to cause a fatality. If we respond to such a near miss it is possible that the root cause(s) are identified and future fatalities prevented. A similar logic applies where an incident results in a minor injury, this provides an opportunity to identify the cause(s) before more serious harm is caused.

Use of incident ratio data studies

Incident ratio data studies have confirmed that for incidents with the same cause(s) their outcomes are generally more likely to result in a near miss or minor injury that a fatality. This is often portrayed by an incident ratio triangle, for example Bird's Triangle, which was developed by Frank B Bird in 1966 as an updated version of the original incident ratio triangle conceived by Herbert W Heinrich in 1931.