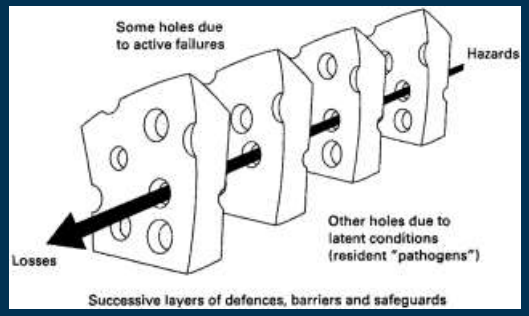
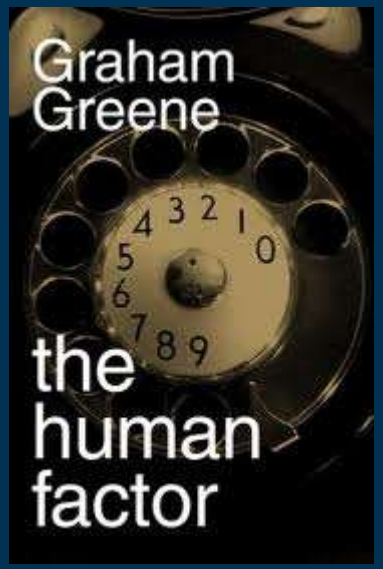
La Sapienza
Università degli Studi di Roma

Safety of Industrial Plants

Lecture 21
The Human Factor



All scientific knowledge is hypothetical and conjectural; the one we can call the method of science is to learn systematically from our mistakes, first daring to commit them and, secondly, systematically going in search of the mistakes we made (The Logic of Scientific Discovery, Karl Popper)



Contents and Goals

- Contents
  - Human Factor
  - Elements of organizational behavior
  - Errors
  - Type of tasks
  - Procedures and communication
  - Errors management
- Goals
  - Learn how to assess and manage a transversal and particularly pervasive risk category
- Professional figures of reference
  - All

Human Factor Contents

- General concepts
  - Accidents due to human factors
  - Murphy's Laws
- Elements of organizational behavior
  - Individual and group responsibilities
  - Motivational elements
  - Group work
  - Cultural elements
  - Management and leadership elements
- Physical environment
  - Noise
  - Lighting
  - Microclimate
  - Vibrations
  - Workplace

Human Factor Contents

- Tasks development
  - physical work
  - repetitive tasks
  - visual inspections
  - complex systems
- Work procedures
  - Communication within and between the groups
  - Registration of the work carried out
  - Information
- Human errors
  - Theory and models of errors
  - Errors in maintenance activities
  - Errors consequences
  - Errors management
- Hazards in the workplace
  - Hazards Identification
  - How to face the emergencies

General concepts

- The study of the human factor requires consideration of both human and engineering sciences, which are traditionally distinct, in order to deepen:
  - The relationship between man and workplace;
  - man's relationship with machines, equipment and systems;
  - man's relationship with work procedures;
  - The existing relationship between men in a certain workplace.

General concepts

- The SHELL model (Software, Hardware, Environment, Liveware, Liveware) is used:
  - Software
  - Situations of disagreement in the application of procedures occur:
    - Due to initial and periodic training problems
    - Due to lack of standardization of certain activities
    - Due to standardization errors
  - etc.

General concepts

- Hardware
- This is related to all the equipments and the machinery used in performing the tasks:
  - Many problems usually concern the work equipment and its state of conservation
    - obsolete equipment that continue to be used
    - not recent, but still valid, equipment that are "banned“
  - Additional problems concern the possibility of forgetting the work equipment
    - criteria for storage
    - criteria for reporting

General concepts

- Liveware
- This is related to the interactions between operators and the manner in which the interactions occur. Problems can arise:
  - Due to character-cultural differences at individual level
  - Due to differences resulting from organizational culture
  - Due to poor (ineffective) communication

General concepts

- Environment
- It is connected to the workplace and the influences that it may determine on who performs specific operations.
- The workplace has to be be appropriate to the operations / activities that have to be performed.
- What follows can lead to problems:
  - urgency
  - Lazy
  - The underestimation of the unfavorable effects that an unsuitable workplace can have.

General concepts

- The role that the consideration of the human factor can play for Safety is gradually assuming importance.
- We have moved from consideration of the typical aspects of communication, decision making, teamwork, etc., to the revaluation of these aspects in the light of the implications, not only from managerial / management point of view, but also for Safety.
- The need to increase awareness of the human factor has been growing, even though it is not still a prime objective.

General concepts

- Training course on Human Factors requires a dedicated approach, also in relation to the addressees.
- The strategic objective that we propose, among others, is to determine a radical change of approach in organizational cultures and put people at the center of the Safety System, with a view to achieving more positive and safer behaviors

General concepts

- Studies on the human factors have a historical tradition in the production world aiming at productivity.
- In the 80s, the studies on the human factor began to involve safety, particularly in the aircraft industry.
- The aviation regulations do not yet provide for specific requirements to be met on the Human Factor. However, some training requirements are mandatory.
- The first indications have emerged after the air crash occured to Aloha Airlines at the Hawaiian Islands on 28 April 1988.
- In this circumstance the role played by the inattention of the maintainers, who were not aware of numerous structural fractures, was clear.

General concepts

General concepts

- An accident due to human factor:
  - In 1988 the flight Alhoa B-737 had a very serious accident as a result of which, at an altitude of about 24,000 feet, a large area of the fuselage was cut off. The airplane was forced to an emergency landing.
  - The plane was inspected by two technicians with considerable experience (over 20 years each) and they did not find any defects.
  - Later it emerged that on the surface of the aircraft there were more than 240 structural cracks.
  - It was realized, consequently, the need to start a program of awareness and training in relation to the human factor.

General concepts

- Analysis of the accident
  - In August 1987 the Boeing Company reported to Aloha the possibility of the problem. The Aloha should thus have made visual inspections of the junction elements.
  - The operation in question, however, is very tedious, especially for the awkward position in which it has to be performed and the length of the necessary controls (about 1600 rivets).
  - It is easy to assume that, after a limited number of joints which were controlled positively, the inspectors assumed that there were not any problems.

General concepts

- Analysis of the accident
  - Problems due to human factors:
    - length of the operation: after having checked many rivets positively , it is natural to expect that they are all "right"; the motivation of the technician fails when he is asked to repeat an operation many times, rather than involve him in an unique "critical" operation
    - type of operation to be performed, mainly in uncomfortable position and in conditions of isolation; the technician has to stay in the upper part of the fuselage of the aircraft, he has to wear safety harness so that he cannot fall, he has to take a torch, an inspection tool and a meter with him

General concepts

- Analysis of the accident
  - Problems due to human factors:
    - unfavorable environmental conditions
    - operations carried out mainly at night, or at the very early morning, when the body is in conditions of partial efficiency, both from the physical and the physiological point of view
    - lack of procedures and support offered by Aloha to its technicians to take account of the human factor.

General concepts

- Operational problems associated to the accident
  - Accumulation of a large number of flight cycles between a structural control and the other.
  - Long times between an inspection and the subsequent one involving the progress of corrosion, fatigue, and accretion of structural failure.
  - Way of execution of a particular type of inspection, characterized by a high segmentation of activity.
- Economic aspects associated to the accident
  - There were not enough airplanes in the fleet of Aloha, therefore the technicians were forced to perform their operations simultaneously on different airplanes and in restricted times.

General concepts

- The Murphy's law

Anything that can go wrong, will go wrong.

- To demonstrate the relevance of this statement, we can consider two accidents occurred at different times.

General concepts

- Woodford – August 23rd, 1947
  - The aircraft Avro Tudor 2 (the largest civil aircraft for civil transport in the Great Britain of that time) was subjected to a change on the transmission system of the rudders motion
  - After the change, due to an assembly error of the mechanisms, the pilot maneuvered the aircraft determining the exactly opposite effects than those he expected. He attempted to raise the right wing, but this tended constantly to remain low until it touched the ground and thus determined the occurred fatal accident
- The assembly error was twofold, on both the command mechanisms of the rudders of the two wings.

General concepts

- FranKfurt – March 20th 2001
  - The Lufthansa flight A320 from Frankfurt to Paris ran into a slight turbulence during the take-off, which forced the commander to maneuver to deal with it; but the controls responded in the opposite way. There were no consequences thanks to the readiness of the commander who passed immediately to manual controls.
  - The fault analysis showed two problems:
    - a chip was reassembled after repair with opposite polarity
    - the command control at the start of the flight did not allow to determine the direction of operation of the rudders
- If the accident had occurred, nobody would have noticed the type of problem and it would have talked about the pilot's error

Elements of organizational behavior

- Individual and group responsibilities

- The work can be considered as an "event" that takes place in the context of a social structure.
- Personalities, feelings and actions of the individuals in a workplace are influenced by :
  - Expectations
  - work climate
  - Rules
  - Communication
  - personal freedom
  - Acknowledgments
- It is believed that moral and ethical values, job goals and standards are the cornerstones of the social context of a company.

Elements of organizational behavior

- Human behaviors are influenced by the social context in which the individuals operate, therefore some conditions are essential to work well:
  - Increase personal motivations
  - Encourage everyone to have an active role in solving problems
  - Propose problem resolution through cooperation between individual
  - Emphasize the benefits of teamwork
  - Encourage workers to share their knowledge
- In the aircraft design, manufacturing and maintenance, like in the society, each person has specific responsibilities in order to improve safety and working conditions.

Elements of organizational behavior

- A technical manager should:
  - Inform the members of the working group about the goals to be achieved
  - Determine the objectives to be achieved. The contribution of each individual is important
  - Discuss the basic rules, procedures and expectations to avoid future disagreements
  - Share mutual respect and recognize the abilities of the colleagues, looking for the interdependence
  - Perform his/her duties with the help of the collaborators
  - Communicate continuously within the working group, sharing his/her thoughts with the others.

Elements of organizational behavior

- MOTIVATION AND DEMOTIVATION
- The main duty of the Company management to improve safety, cooperation and teamwork is to motivate their staff
- A common definition of MOTIVATION is:

“the force that gives energy, guides and supports the behavior”

- The main motivations on work are:
  - Money, even if its importance has not to be overestimated, and that, moreover, are not enough to make a person feel realized
  - Social interaction, which has a considerable importance and that is added to the state of need of the worker

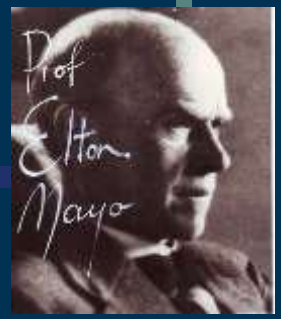
Elements of organizational behavior

- Intrinsic and extrinsic motivations
- EXTRINSIC MOTIVATIONS:
  - Salary increments
  - Promotions
  - Benefits
- INTRINSIC MOTIVATIONS:
  - Good professional performance
  - Greater personal satisfaction

Elements of organizational behavior

- HOW CAN WE MOTIVATE PEOPLE?
- There is no a simple answer to this question, but we must consider that:
  - Work is a social activity
  - The need for recognition, security and sense of belonging is more important in determining the moral of a worker than the physical conditions in which he/she works
  - The worker is a person whose effectiveness is conditioned by the needs of both internal and external working conditions
  - The team work does not happen by accident; it has to be planned and developed to create cohesion, improving human relations

Elements of organizational behavior



- To demonstrate these considerations, we can illustrate some experiments on human behavior developed in Chicago between 1924 and 1932 by the Western Electric Company.

- In these experiments Professor Elton Mayo examined the productivity and working conditions.

- The outputs of these researches were called “Hawthorne effects ” (Hawthorne, Chicago).

- Mayo examined the connections between productivity and working conditions. He wanted to find out what effects fatigue and monotony have on productivity and how to control them through, for example, work breaks, time, temperature and humidity.

Elements of organizational behavior

- Six women were chosen from the assembly line, separated from the rest of the factory, making frequent changes in the way they worked, discussing with them preventively.
- These people were made aware of the will to carry out such an experiment to evaluate the productivity of the company.
- In the second series of experiments two women were selected, letting them choose four colleagues with whom to form a working group, varying alternately :
  - The breaks and their durations
  - The type of meals
  - The time of entry and exit
- The productive results were far more higher than the average!

Elements of organizational behavior

- What happened during the experiments?
- Six individuals became a team work, who spontaneously decided to participate in the experiment, they were happy to work without constraints or limitations given by the management.
- They were satisfied, as a result of being able to work in an environment without pressure, as never happened
- Medical consultations showed a complete lack of effort, and absences at work decreased the 80%.
- Every woman ranged her way to assemble the pieces to defeat the monotony in accordance with her intelligence

Elements of organizational behavior

- NORMS OF THE GROUP

- A norm is a tacit agreement between all the members of a group with respect to the behavior that everyone should follow.

- The norms are informal practices or unwritten rules that are accepted by the group :
  - They facilitate the interaction
  - They are generally developed to solve problems which have ambiguous solutions
  - During the work, they evolve and stabilize

Elements of organizational behavior

- There are different kinds of norms:

- POSITIVE NORMS :
  - They are behaviors in order to improve the working group
  - They have mainly positive effects on the organization:
    - Non mandatory meetings during non-working days
    - Double checks of one's work
  - They are safe
  - A violation by a member may be sanctioned by the other members of the group.

Elements of organizational behavior

- NEGATIVE NORMS :
  - They are unsafe as non productive
  - We act according to these norms because they generally allow us to save time and operations
  - They make the work faster :
    - An experienced worker who shows a new employee a shortcut or commonly accepted practices
    - An employee who works in accordance with memory or not following the procedures
  - They may become " killer norms" when the working group cannot see the danger of these shortcuts or accepted practices.

Elements of organizational behavior

HOW PRESSURE CAN INFLUENCE SAFETY AT WORK

- Too much pressure due to the culture of the organization and management decisions can contribute to errors.
- The Airline, in fact, may unwittingly support practices that make the plants unsafe :
  - It does not give to technicians enough time to review an aircraft
  - It does not give to technicians the power to stop a suspect product.

Elements of organizational behavior

- SAFETY CULTURE

- Safety takes precedence over all the parameters considered in making decisions.
- Every worker, regardless of his/her position, firmly believes that safety should be ensured above anything else.
- Safety permeates every aspect of the company and all its operation.
- We have to, therefore, develop a corporate structure and a climate where safety takes life naturally
- To combat the errors a company has to:
  - teach how mistakes can be avoided
  - promote habits which consider safety first.

Elements of organizational behavior

- CULTURE OF RELATIONS

- It s'a climate in which people are prepared to report their mistakes and correct deficiencies.
- The key to success of a safety culture is the collection of information about the types and causes of errors which are prevalent in the organization:
  - By creating a system that collects, analyzes and distributes information on the occurred accidents
  - Supporting with each employee this collection of information.

- A culture where people are reprimanded is not wished.
- An environment where people are encouraged to provide important information related to safety is wished.

Elements of organizational behavior

- NATIONAL CULTURES

- The different cultures in different countries are another aspect of the corporate culture that must be considered

- There is indeed a relationship between national cultures and cultures of safety

- The reality of an International Company is a mixture of different cultures and different approaches with reference to safety

Elements of organizational behavior

- Hofstede (1984) defined the different national cultures as describable by the following features:
- Social differences, defined as the distance between the class that has the power of decision and therefore it gives rise to social inequality, are accepted and legitimized
  - Where social differences are marked, it is expected that the leaders are autonomous in their choices and decisions
  - With little marked social differences, cultural upper classes consider and treat the subordinated classes as if they were colleagues
- Sexism, referring to differences of social roles assigned to women and men and to their social dominance

Elements of organizational behavior

- The individualism, i.e. the prominence given to individual companies rather than considering the best choice the one of creating a good group

People who do not decide

- The resolution of uncertainty, understood as the attitude with which we deal with unclear, unstructured and unpredictable situations:
  - Some cultures look for clarity and order, promoting the establishment of clear rules
  - Some others, instead, consider uncertainty as a natural part of life

Elements of organizational behavior

- THE TEAMWORK
- We already mentioned that to work safely within a complex environment, the organization's staff should know:
  - How the actions of the individuals reflect in the company
  - How to best use the available resources in maximum safety
  - How disseminate a positive safety culture within the company through specific actions

Elements of organizational behavior

- Some features may make clear what team means.
- The size:
  - A team consists of more than one person
  - Every new inclusion of people requires more time, resources and coordination to complete the task
  - A team with many participants can fractionate and create subgroups that may have different goals than those initially declared as primary
  - The return performance decreases when more people are included
  - Although the optimum number of components depends from the whole group, the performance losses become significant with more than 10 people

Elements of organizational behavior

- A common target:
  - It consists of several milestones
  - The common target justifies the existence of the team itself
  - It Is communicated to all team members
  - It is an accurate indicator of the work done by the team
- The interdipendence:
  - Circumstance for which each member depends on others to complete the work
  - The work objectives are not activities that can be carried out properly without mutual relations within the team

Elements of organizational behavior

- CHARACTERISTICS OF AN EFFICIENT TEAM
  - A clear purpose, accepted by all the members
  - Informal interaction, with no tension between the members
  - Participation in decision-making and in all the activities
  - Everyone's ability to listen to each others
  - Ability to show disagreement without delay if the situation requires it
  - Full and complete communication
  - Clear perspectives on the roles to be filled
  - Sharing of command and responsibilities
  - Continuous relations outward to maintain credibility
  - Have clear ideas on team functions

Elements of organizational behavior

- TEAMWORK AND COMMUNICATION
- Asynchronous communication:
  - It is necessary in the operations, characterized by large working teams
    - E-mails between members that operate with different timing
    - Pro-memory and notes
  - It determines changes very slowly
- Synchronous communication:
  - There is a minimum delay between sending and receiving of a message
    - Face to face conversations
    - Communication by radio
  - It is necessary when teamworks become more interdependent with each other

Elements of organizational behavior

- TEAM COORDINATION
- Seven useful characteristics aiming at reducing the likelihood of human errors have been identified :
  - Leadership: direct and guide the activities of other people. It stimulates teamwork
  - Analysis of the mandate: make long-term plans to better organize
  - Adaptability and flexibility: change the actions under way to meet new needs
  - Awareness of the situations: always know what is happening in the working group
  - Decision-making capacity: making decisions based on real facts
  - Communication: providing appropriate information to all, using the feedbacks to improve
  - Support our own ideas, and be convinced of our own mistakes

Elements of organizational behavior

- TEAMWORK AND ASSESSMENTS
- It is important that the staff receives the assessments upon the completion of their work.
- The assessments are crucial for the development of better mental models.
- Without feedback is difficult to improve the person's capabilities.

Elements of organizational behavior

- ELEMENTS OF MANAGEMENT AND LEADERSHIP
- Leadership is the ability to direct and coordinate the activities of the members of a working group and encourage them to work together as a team
- It is not a characteristic of a person, as it was believed 30 years ago, but it arises from an appropriate position of control
- The supervisors or leaders of the various teams act as the intermediaries between different points within the Organization

Elements of organizational behavior

- There are two types of leaderships (which is better depends upon position that one has to play, and in any case the ideal is a mixture between the two):

- **Authoritarian leadership**
  - He /she is a person who say all that to be done and the right way to follow for all the team
  - He /she tends to make all the decisions of a team and to control all resources
  - He /she structures the working team as a hierarchy

- **Participative leadership**
  - Each member of the working group should participate actively
  - He / she encourages the participation of the team members

Elements of organizational behavior

- The Leaders have many responsibilities

- Here are some of them:
  - Supervise and coordinate activities
  - Delegate tasks to the right people
  - Define personal responsibilities and expectations
  - Focus on critical aspects of the work
  - Adapt the workplace to the necessary changes
  - Keep people informed about the most relevant facts in the development of the activity
  - Ask information to the members and answer them
  - Provide answers about the productivity of each individual
  - Create and maintain a professional atmosphere
  - Promote teamwork
  - Manage workloads and stress
  - Train councilors to be competent in their roles

Elements of organizational behavior

- Here are the behaviors that a true leader has to demonstrate :
  - Specify and transmit the assignments to everybody
  - Coordinate and collect the necessary information
  - Make positive environment to motivate those who work in the team
  - Solicit and accept advices from the members of the team work
  - Inform in a positive and proactive way about the mistakes made
  - Focus the attention of the team on the task to fulfill

Elements of organizational behavior

- Consider and evaluate risks and alternatives
- Support and assist the situations of each member of the working team
- Provide complete information to the entire team
- Inform the whole team of the progresses made
- Realize and manage possible overworked
- Provide feedback on the performance of the team:
  - Positive evaluations: invite people to continue in this direction
  - Negative evaluations: they should be constructive and not in the form of punishment
- He / she has to continually assess the situation

Errors

- Despite the evolution of the accident prevention regulations, the recorded data appear very worrying:
  - about 1 million injuries a year, of which about 14,000 with permanent consequences and 1200 with deadly consequences
  - direct and indirect costs related to injuries represent about 3% of Gross Domestic Product.
- An analysis of the events shows an increase of incidents in which workers play an important role. Part of the responsibility is attributed to the insufficient attention given to the human element and to the environment with which it interacts.

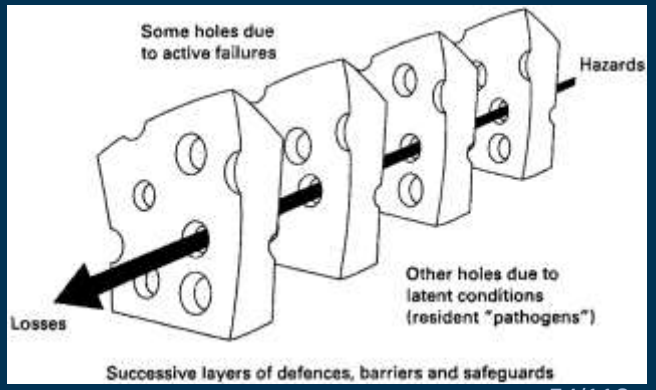
Errors

- The creation of appropriate safety conditions in a production system is based on a careful consideration of all the key components that characterize it (productive resources, man, environment).
- Man, in fact, should be regarded as a very special resource production, characterized by his reliability (i.e. propensity to error), and inserted in a context that may influence his behavior.
- The reliability of the binomial man - environment is determined by variables which are not easily predictable.

Errors

- The evaluation of the human factors in a complex manufacturing organization requires the consideration of, at least, the following variables :
  - cultural and organizational characteristics
  - characteristics of the workplace
  - defenses, barriers and safeguards
  - external factors
  - personal factors (internal factors).

- Human error can be regarded as a failure in achieving desired objectives of the planned actions:
  - carelessness
  - minor errors
  - errors
  - violations.

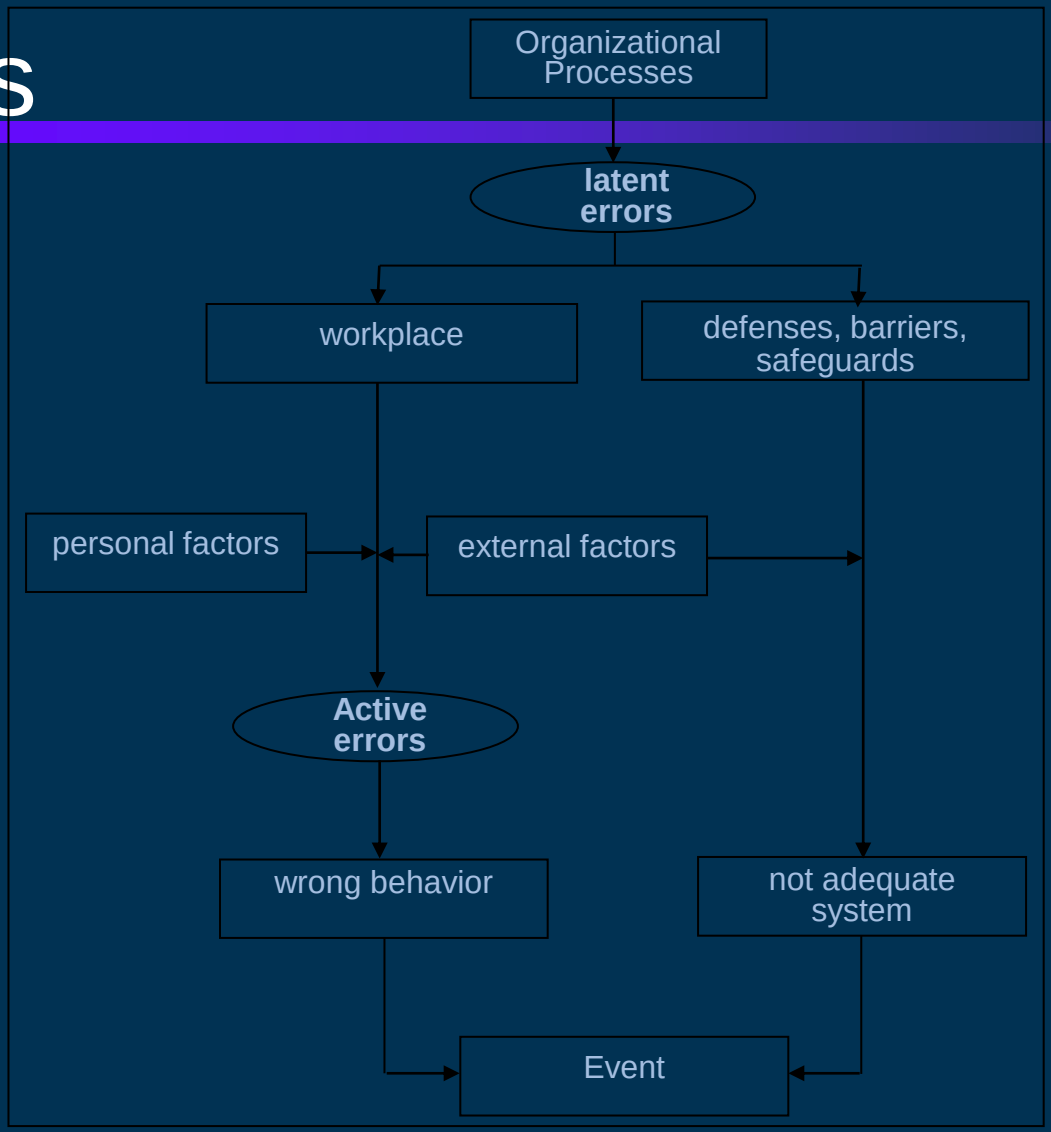


Errors

- In relation to human behavior in work situations it is possible to identify three operating modes considered in conjunction with the most frequent types of errors:
  - executive behavior
  - operational behavior / implementation monitoring
  - management behavior.
- A further classification of errors, especially useful for analyzing the causal accidents, is the following one:
  - active errors
  - latent errors.

Errors

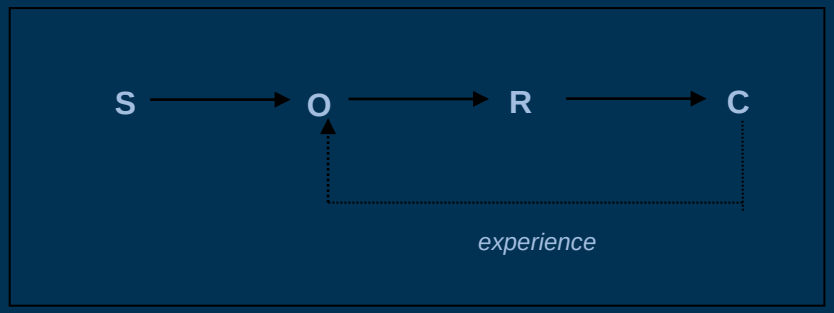
Causal analysis of accidents due to errors



Errors

- Error management is the set of methods to reduce the number of errors and / or to control the consequences, through the implementation of measures - not strictly techniques - which tend to improve the resistance of the organization to errors.
- The starting point of the error management is due to the definition of appropriate architectures representing both human and productive resources, and the assessment of the possible interactions between them.

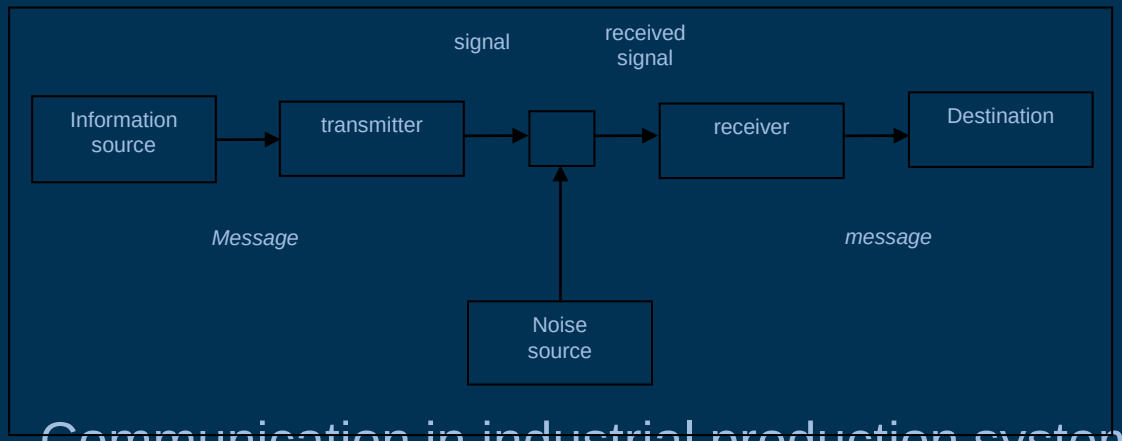
Errors



O-> Operator
S-> Stimulus
R-> Reaction
C-> Consequences

Errors

- Another important factor to take into consideration is represented by the verified conditions of communication.



Shannon-Weaver's Model

- Communication in industrial production systems is characterized by some special features:
  - frequent asynchrony
  - high parallelism
  - distances…

Errors

- Communicative acts (horizontal and / or vertical) in a productive organization do not represent simple steps of information, but propagation of meaning, with actual negotiations of understanding.
- Quantitative and qualitative factors have to be taken into consideration:

QUANTITATIVE FACTORS

Reliability of the message
Appropriateness of time and place
The physical means by which the message is transmitted
Coding mode (clarity and use of specific terminology)
Adequacy of the "feedback"
Dynamism
Irreversibility
Contex

QUALITATIVE FACTORS

Contextual appropriateness
Transparency of the objectives of communication
Situational adaptability
Explicit recognition of obstacles and barriers to communication
Recognition of the existence of interpretative filters

Errors

- The aircraft transport sector is a valuable set of experience and information.
  - MEDA – Maintenance Error Decision Aid methodology, which is a method of investigation for the analysis of errors, mainly aimed to identify the triggers and corrective actions.
  - ADAMS – Aircraft Maintenance and Dispatch Safety program (1996 – ongoing).
  - STAMINA – Safety Training for the Aircraft Maintenance Industry program (1998 – 2000).
  - AMPOS – Aircraft Maintenance Procedure for Optimisation System (1999 – 2001).

Errors

- voluntary and mandatory standardization concerning safety industry is strongly focused on material resources and, to some extent, on the environment (which is considered too "disconnected" from man and material resources).
- Technological evolution is not enough to ensure the best levels of safety and, in many cases, it arises new problems in this regard.
- The experiences of error management in the aircraft sector are a useful starting point to experience similar projects in other areas of production that inevitably should involve institutional figures of reference for safety and for information management.

Errors

- The "dirty dozen" of errors
- The "Dirty Dozen" scenario is a model for the analysis of human errors
- The objective is to maintain high the level of attention
- These observations can be used in all the aviation segments, since anyone can adapt them to their own working reality
- These are the 12 most common causes for which a person makes mistakes
- There are also indicated remedies to help avoiding errors of judgment.

Errors

- Errors, when they occur, can be caused by the combination of the following causes:
- Lack of communication. Both verbal and written communication, or a combination of the two.
  - Remedies:
    - Use registers, spreadsheets, etc., to resolve doubts
    - Discuss about the work to be done or what has been done
    - Do not assume anything
- Complacency. Lack of the right attention for repetitive jobs or for jobs made several times.
  - Remedies:
    - You may expect to find a fault
    - Do not ever sign up for something you did not do

Errors

- Lack of knowledge. It is a common cause in errors of judgment.
  - Remedies:
    - Be trained
    - Use updated manuals
    - Ask someone who knows things

- Distraction. It is considered to be responsible for about 15% of all the errors occurring in maintenance. It happens when you leave physically and mentally a job.
  - Remedies:
    - Always finish the job before any other contact
    - Mark the jobs that are completed
    - When you return to do a task, make three steps back
    - Use detailed check lists

Errors

- Lack of teamwork. It is connected to the lack of communication. A good teamwork is of essential importance, since there are many people involved.
  - Remedies:
    - Discuss about what, who and how a job has to be done
    - Be sure that everyone understands and agrees
- Fatigue. It worsens a person's ability to work effectively
- The possible causes are:
  - Sleep, environmental factors, difficulties of the work
  - It is a very insidious cause, because those who are subject does not realize it.
  - Remedies:
    - Be alert to symptoms both on themselves and on the others
    - Avoid heavy works in the wrong times
    - Sleep and do exercise regularly
    - Ask others to check our own work

Errors

- Lack of resources
  - Remedies:
    - Check suspicious areas and the spare parts to be required
    - Order and store in advance the spare parts before they are required
    - Know the sources of all the available spare parts
    - Maintain a high standard, and in case of doubt do not allow the airplane works
- Pressure. Some companies are eager to see the works finished. The secret is the ability to recognize when such care is unrealistic or excessive.
  - Remedies:
    - Be sure that rush is not self-induced
    - Communicate our own attentions
    - Ask for extra help
    - Just say “NO”

Errors

- Lack of assertiveness. In alcune occasioni serve la fermezza per assicurare che i problemi non siano sottovalutati.
  - Remedies:
    - Registrare nel diario giornaliero le attività svolte
    - Rifiutarsi di compromettere gli standard qualitativi
- Stress. E' una parte normale della vita di tutti i giorni. Bisogna riconoscere quando diventa eccessivo.
  - Remedies:
    - Essere consapevoli di come lo stress può influenzare il proprio lavoro
    - Fermarsi e ragionare con razionalità sul problema
    - Determinare un percorso razionale per svolgere il lavoro, e seguirlo
    - Prendersi delle pause dal lavoro
    - Discuterne con qualcuno
    - Chiedere a qualcuno di controllare il proprio operato
    - Esercitarsi fisicamente

Errors

- Lack of awareness. It often happens to very experienced staff, who cannot foresee all the consequences of the work they are doing.
- Manuals do not avoid failures.
  - Remedies:
    - Think about what in case of accident may happen
    - Check that our own actions are not in conflict with existing modifications or repairs
    - Ask others if they see problems with our work
- Norms. They develop within the working group in place of the manuals, dictating wrongdoings.
  - Remedies:
    - Always work according to the instructions
    - Know that the “norms" are not good

Type of tasks

- This section explores the meaning of knowledge to better understand the relationships between it and the four types of productive tasks we may encounter :
  - physical work
  - repetitive tasks
  - visual inspections
  - complex systems

- Each of the above aspects and the implications knowledge necessary for each of them will be taken into consideration

Type of tasks

- What does knowledge mean?

- We may say that knowledge is understood as a set of cognitive abilities and limitations that may be involved in our lifetime, and especially during the course of our work

- Apply knowledge to our work means :
  - Be careful
  - Use memory
  - Follow the process information
  - Make diagnosis
  - Make decisions
  - etc.

Type of tasks

Our job performances depend on the ability to apply our cognitive abilities

In Safety, attention is an essential mechanism to reduce uncertainty and maintain an awareness of the situations that helps to avoid errors

Type of tasks

- Human capabilities and processes
- Some of the human skills that can be included in the definition of knowledge are:
  - Perception
  - Attention
  - Memory
  - Planning
  - Understanding
  - Information interpretation
  - Problems solving
- We conduct our activities and interact with the environment through the application of these skills and these processes

Type of tasks

- Levels of knowledge
- We can say that some activities require cognitive efforts and higher mental processings
  - Low level:
    - Manual activities
  - Average level:
    - Interpretation of the information
    - Activities carried out by means of Personal Computers
  - High level:
    - Complex activities
      - Mental processes
      - Personal Ability, intelligence and sensitivity
    - Alternative solutions to problems

Type of tasks

- PHYSICAL WORK
- All the activities that require physical efforts and manual skills
- Technicians are require to have both knowledge and skills to solve the problems:
  - diagnostic capabilities
  - Manual skills which are easier to teach and to learn
- It requires little intellectual effort and little mental processing

Type of tasks

- REPETITIVE TASKS
- The productive activity, for example, is composed by different tasks, some of which are repeated every day, in each unit of time
- Their main goal is to produce goods or provide services, and therefore the technicians are very often called to perform a number of actions, which are often very repetitive
- Boredom is the main risk for the workers
- They require low-medium intellectual efforts

Type of tasks

- ERRORS IN PRODUCTION
- In the production, the number of errors is very large
- Omissions due to interruptions
  - Distractions and interruptions occur when:
    - low-level tasks are performed
    - We perform tasks that we know very well, and that we face lightly
  - They can be caused by stress due to the limited time available
  - The possible remedies are:
    - Use written work plans to follow
    - Inform the workers about the effects of distractions and interruptions

Type of tasks

- Omissions due to work sheets
  - If the technicians follow the production sequences written on the work sheets, the probability of distractions increases constantly while they are moving around the machine
    - If the various stages of production are physically separated, the work sheets should take it into account

Type of tasks

- Omissions due to deviations from work sheets
  - The technicians ignore the sequences on the work sheets :
    - They rely on their own memory
    - They consider them useless
    - They record their activities all together during work breaks, and not one by one, at the time of their execution.
  - Performing the same tasks on a number of different machines, it happens that:
    - The tasks are mixed
    - Some tasks are omitted
    - They perform more tasks than those necessary
  - The work sheets help the technicians to remember the tasks to be performed

Type of tasks

- Errors due to incompleteness
  - The work sheets are used to let the technicians known limits and details
    - They have to include all the limits
    - The different specifications have to be appropriate for each production
  - If a technician does not use the work sheets, he may risk confusing the technical details of the different products.

Procedures and communication

- DEFINITION OF COMMUNICATION
- Communication:
  - It is a complex, dynamic and evolving process, with many applications
  - Its quality can determine the success or failure in achieving a result
  - It is an integral part of safety, and it is important that everyone understands it
  - It is a prerequisite to play an effective technical work

Procedures and communication

- Functions of communication
- Communication has several functions; we will briefly analyze some of them to better understand what really happens when we talk to someone :
  - To provide information: our colleagues, as well as manuals and newsletters, are an important source of information.
  - Sometimes the best source of information is a chat with a colleague in front of a coffee machine.
  - To establish a relationship: communication helps to build relationships and create an environment in which we work better.

Procedures and communication

- To perform a task: communication is clearly a means by which the teams coordinate their work.
- To determine some behaviors: the way we communicate creates expectations to the other colleagues.
  - If you arrive to work on time, the others expect a serious and professional behavior from you
  - If you do not fill in working papers properly, the others will expect a superficial and wrong behavior from you.

Procedures and communication

- Responses
  - They are used to check the correct operation of the activity
  - They are crucial to plan every improvement
  - They reinforce the value of the observations proposed by each worker
  - They ensure that the work program is working well, or has been properly revisited.

Procedures and communication

- NOT to communicate is not possible
  - It is a fundamental property of our behavior
  - Each of our behavior is a message
  - The activity or inactivity, the words or silence, are all messages
  - Our behaviors affect other people, which in turn cannot but answer: they communicate too .

Procedures and communication

- How and what communicate
  - Another aspect is the quality and the style of the interactions between people
  - HOW things are communicated is as important as WHAT is communicated
  - Although the words are the same, the clarity and the pitch of the voice can significantly alter the function of communication

Procedures and communication

- Verbal and non-verbal Communication
  - We have to pay constant attention to sent and received messages in any form.
  - Verbal communication includes:
    - Give orders
    - Meetings with workers
    - Relations with other people
  - Non-Verbal communication includes:
    - Body language
    - Sight
    - Established signals
  - Face to face talk provides important information to improve mutual understanding

Procedures and communication

- Written Communication
  - They are very important in the industry, as:
    - They allow to store the information for a long time
    - They help to preserve the information that have to pass through many people
    - They are less prone to misunderstandings
    - They are critical tools for safety
    - Misunderstandings can occur only when communications are too complicated or sophisticated.

Procedures and communication

- COMMUNICATION WITHIN AND BETWEEN GROUPS
- Within the groups
- It is a process that can be both difficult and destructive, or rewarding and productive for effective business management.
- The lack of communication may cause some problems, some of which have direct effects on safety.

Procedures and communication

- Hierarchy:
  - Technical organizations tend to be extremely hierarchical
  - If this type of organization is beneficial, the performance of the team work may potentially decrease :
    - Most young people are reluctant to express disagreement with the highest able
  - Communication within the working groups should always be as open as possible

Procedures and communication

- inclination to authority :
  - It was analyzed to explain the poor performance of some team, when there was a marked difference in terms of authority among members
  - A large gap between those who have the authority and who does not have it, reduces the performance of a team, as well as the opposite situation.
  - The ideal situation is:
    - Have a recognized authority
    - Allow everyone to freely express their own ideas

Procedures and communication

- **Firmness :**
  - It consists on recording a series of rights granted to each member of the working group :
    - Say NO
    - Express our own ideas
    - Ask for explanations
  - It means being able to:
    - Make our voices heard
    - Be understood
    - Share our ideas with others
  - It is a key feature to have a good group work

Procedures and communication

- Solution of the conflicts:
  - A recent study shows that we spend 14% of our working time in discussions.
  - The main causes of discussion are:
    - Communications breakdown
    - Poor working effectiveness
    - Failure of procedures
    - Insufficient resources
    - misunderstandings
    - personal conflicts
    - Lack of cooperation, which derives from a inadequate organizational structure
      - Not clear instructions
      - Lack of experience of the supervisors
      - Different standards of behavior among the members
  - Conflicts can seriously disturb the workplace

Procedures and communication

- Among different groups

- A topic of fundamental importance is that of coordinating different groups which work to reach a goal
- A significant number of incidents reflect the difficulty of working with multiple groups on the same project
- Communications have to be prepared to transmit general information
- It is important to provide the technicians with the solely necessary information

Procedures and communication

- Multicultural groups :
  - When we operate in an "international" environment, we interact with different cultures.
  - A statement that seems obvious and normal in one culture may have a completely different meaning in another
  - Interacting between different cultures the solution to avoid such problems is:
    - Use a simple and common vocabulary
    - Speak slowly in verbal communications
    - Ask others to speak slowly when the information is not clear

Procedures and communication

- Improve the communication system

- Formal written records:
  - They are permanent records of the activities developed together with the technical department
  - They have a legal value as evidence of the controls
  - They are written reports about the problems found by the inspectors
- Informal written notes:
  - They can replace trust on memory and verbal communications
  - They can be addressed to an individual or to the entire workgroup
- Digital recordings:
  - They can replace the informal notes for those who do not like writing

Procedures and communication

- Software:
  - E-mails, electronic newsletters, databases, help to:
    - Transfer information between people
    - Give access to information simultaneously
    - Give more flexibility in the presentation of information
- Blackboards:
  - They are useful to record information for short periods of time
  - They may be used to communicate information to all members of the working group
  - Information that could serve further cannot be deleted if they are not transcribed in registers
- Formal meetings:
  - They are useful to present information to all the technicians
  - They allow discussions and exchanges of ideas
  - They ensure that each technician receives the same information

Error management

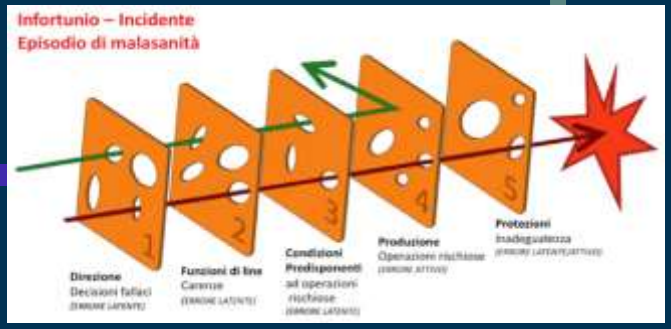
- ERROR MANAGEMENT

Avoid errors is difficult,

but we can manage them

Manage the errors means discovering the causes and types, and prevent them

Error management



- Reason's failures model
- James Reason's model shows how important is to recognize and prevent the errors.
- He made a distinction between active and latent errors.
- Active errors. They are caused by people whose actions have immediate harmful consequences, such as :
  - A pilot who makes a wrong move will immediately notice the incorrect response of the aircraft
  - A technician that damages the oil circuit causing leakage of liquid immediately notices the error
- Latent errors. They are those whose effects cannot be seen, if not as a result of other actions :
  - The incorrect installation of a detector can cause a slow loss of oil, and therefore the stop of the engine for many hours after its installation

Error management

- These two types of failures can interact between them to penetrate the system and cause an accident
- This happens when all the protection mechanisms at each level of the system fail
- Recognize and prevent the error
  - Each type of error helps to choose a specific training to correct it

Error management

- Strategies to manage errors
- Reduce the error. We directly intervene to the source of the error through:
  - improving accesses
  - improvement of lighting
  - better training of technicians
- Stop the error. It is assumed that the error has already happened. This includes:
  - inspections, checks and tests after the execution of the work
- Tolerate the error. It refers to the ability of the system to absorb the error without negative consequences :
  - Redundancy of multiple hydraulic or electric systems
  - An inspection program capable of detecting fatigue cracks before they reach a critical length

Error management

- MEDA (Maintenance Error Decision Aid)
- It is an investigation methodology for the analysis of human errors
- It was developed and tested by Boeing, with the contribution of numerous Airlines (1993-1995)
- It is based on the contribution of maintenance technicians aimed at the study of the event :
  - The technicians are the best source of information
  - Technicians provide an important contribution to study what can be done to allow prevention
- There is a team approach to the problem, to avoid blaming the single individual

Error management

- Goals of the method
  - It is a tool of investigation on human errors
  - It is a method that can be applied only after that the incident occurred.
  - It was studied for the analysis of :
    - Errors on maintenance
    - Factors that contributed to those errors
    - Possible corrective actions to avoid these situations

Error management

- Methodology
  - The method follows a simple process:
    - EVENT. When an error occurs, the maintenance company has the responsibility to select the possible causes to be investigated
    - DECISION. After having solved the problem, the operator makes a decision: was the failure related to maintenance? If so, we begin the study with MEDA
    - SURVEY. We start recording information on the aircraft:
      - When maintenance was made ?
      - When did the accident occur?
      - what error caused the accident?
      - What were the factors that contributed to it?
      - a list of possible prevention strategies

Error management

- CORRECTIVE ACTIONS. The technician decides the priorities, reviews the information and tracks prevention strategies to prevent or reduce the likelihood of similar errors in the future
- RESPONSES. The technician provides the responses to maintenance technicians, so that they know the changes made in the organization as a result of MEDA.
  - The technician has to be sure that all workers participate and accept these changes.

Error management

- To collect information on the accident, interviews with the people involved in the fact are made.
- During the interviews, we fill out a form, based on a model and on numerous checklists.
- There are three survey areas:
  - What happened:
    - General information (name,Company, aircraft, date, place, etc.)
    - Consequences of the event (delay, cancellations, etc.).
    - Type of maintenance error (improper installation, misconduct testings or inspections, etc.).

Error management

- Why and How it happened:
  - Identification of the factors that have contributed (individual, social and organizational, environmental)
  - Analysis of how these factors have led to the event
- Failure of protective barriers and potential solutions:
  - Existing procedures, processes and policies that have not worked in preventing the accident
  - Suggested corrective actions at the local level to prevent the accident from happening again
  - Corrective actions outside the immediate control of maintenance technicians and managers

Error management

- MESH (Maintenance Engineering Safety Health)
- In 1992 the British Airways commissioned a group of specialists from the University of Machester, led by prof. Reason, to develop a method of investigation to be applied before an accident.
- The purpose is to evaluate the goodness of the safety of the workplace and the organization in general.
- The method MESH evaluates how much the system is resistant to the situations that can lead to an accident.
- It helps the organization to decide the priority of corrective actions and targets

Error management

- Goals of the method
  - The purpose is to identify those 2-3 conditions that require special attention, and that, if unattended, can lead to :
    - Loss in quality
    - Future errors in management
  - The reviews are made periodically, at predetermined intervals
  - Thanks to its flexibility, this method can adapt easily to the reality in which it is used
  - It is a confidential but not anonymous method. People are asked their names and serial numbers before using the system.

Error management

- Methodology
  - The method evaluates:
    - LOCAL FACTORS, the relative problems in relation to the work done is assessed by means of a Personal Computer, with a scale of 5 points. l
    - The considered local factors are the following:
      - Knowledge and experience
      - Morale and motivation
      - Tools and equipment
      - Fatigue
      - Pressure
      - Time of the day
      - environmental conditions
      - Manuals and procedures
      - Drawbacks
      - Safety equipment

Error management

- ORGANIZATIONAL FACTORS, regardless of the type of the workplace:
  - structure of the organization
  - Personnel management
  - Quality and supply of equipment
  - Training and Consultancy
  - Commercial and operational pressures
  - Planning and programs
  - Maintenance of buildings and equipment
  - communication

Error management

- Stages of evaluation
  - Unlike the MEDA method , everyone has to specify their personal and working details
  - The analyzed and evaluated factors are provided with definitions and examples, generated through discussions with the technical staff before the configuration of the investigation system
  - Comments about those factors that are consider the most problematic are allowed. Suggestions for solutions are as well encouraged.
  - At the end of this method the evaluator has more profiles than the analyzed factors. He can thus identify which of these require more attention and care
    - The organization should focus its attention on the worst two or three local factors.