Engineering Risk Management
Lecture 9

Major industrial accidents & crisis mgt

Prof. dr. ir. Genserik Reniers
Safety and Security Science Group (TU Delft)
KULeuven (Campus Brussel, CEDON)
UAntwerpen (ARGoSS)

g.l.l.m.e.reniers@tudelft.nl
Genserik.reniers@kuleuven.be
Genserik.reniers@uantwerpen.be

“Usefullness” of major accidents

- Learning from them
- Create awareness among practitioners, authorities and public
- New legislation
- Some iconic examples are given hereafter

Chernobyl

- On April 25, 1986 in the former USSR (now Ukraine), a nuclear chain reaction in the reactor went out of control creating explosions and a fireball which blew off the reactor's heavy steel and concrete lid.

- Lost control of the reaction was blamed on an unauthorized experiment in Reactor No. 4.

Chernobyl

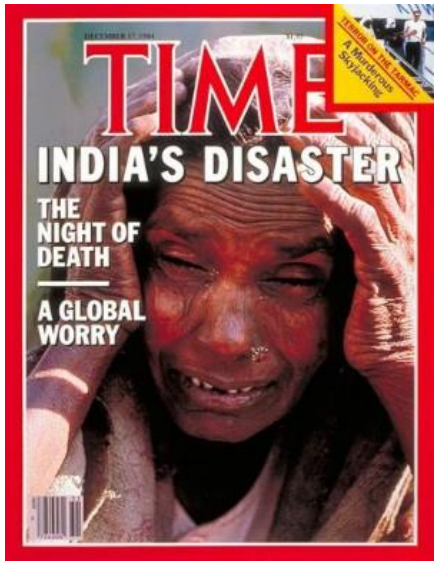
- Thirty-one people died immediately (within three weeks) in the explosion.
- 25,000 rescue workers since then died as a result of radiation.
- More than 2 million people were affected by the disaster.

Chernobyl

- The main health concern centered around exposure to radioactive iodine.
- 600,000 people were permanently relocated after the explosion.
- Now years after the disaster, the people of Ukraine are still dealing with the radioactive byproducts.

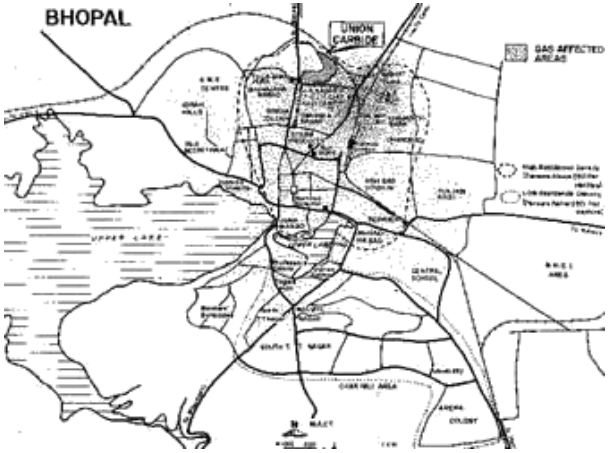
Bhopal Disaster

- On the night of Dec. 2nd and 3rd 1984, a Union Carbide plant in Bhopal, India, began leaking 27 tons of the deadly gas MIC. Soon it spread out to the nearby population.
- Some 15,000 people died from the disaster and about 120,000 people were injured.
- Even 15 years later, researchers found chemical compounds in the water near Bhopal at levels 50 times higher than those specified by the EPA as safe.



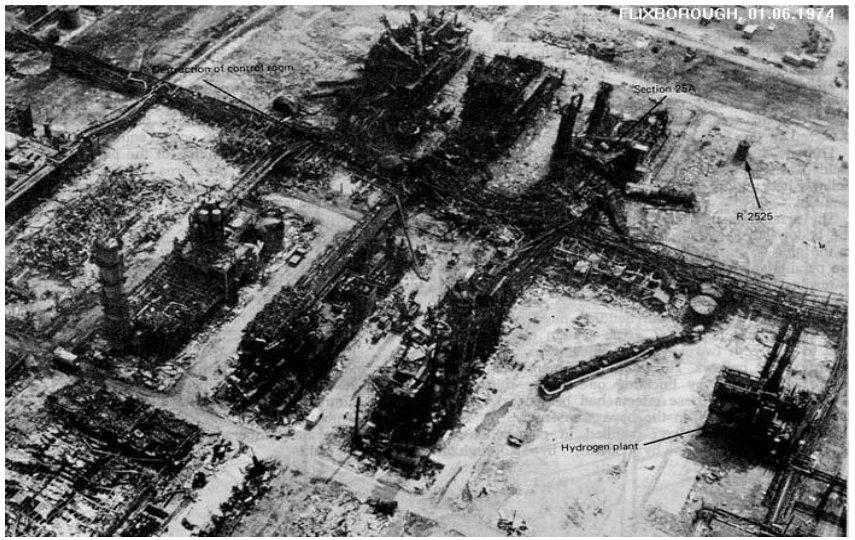
Bhopal Disaster

- In 2001, the chemical corporation Dow Chemicals purchased Union Carbide, thereby acquiring its assets and liabilities.



Flixborough disaster

- Largest peacetime explosion ever to occur in the UK
- Date: Saturday, 1 June 1974
- Location: Flixborough chemical plant owned by Nypro (UK) Ltd
- Deaths of 28 workers on the site
- Widespread damage to property within a 6 mile radius around the plant



Flixborough disaster

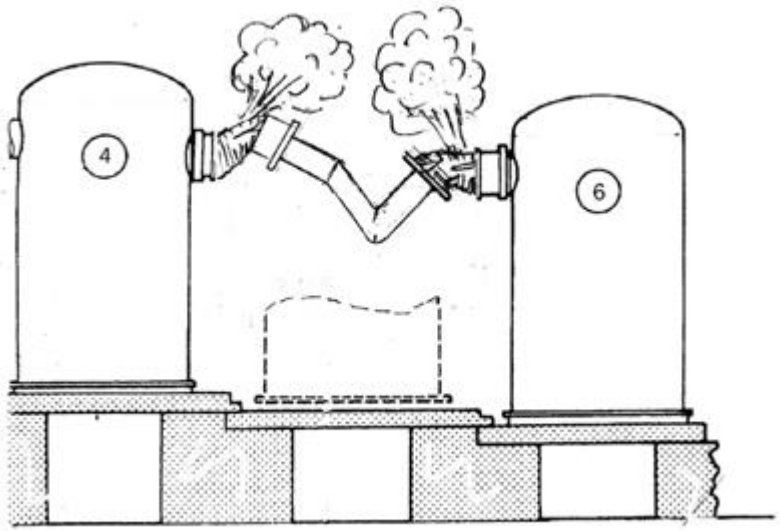


Fig.2 View of fractured temporary pipe

- **Human error analysis**
  Table (next slide) gives causes against the different types of errors that occurred.

- **Direct cause**
  Failure of the 20 inch bypass pipe led to huge release of inflammable cyclohexane vapour which ignited

- **Root causes**
  A badly designed 20 inch bypass pipe installed rather than finding reasons for the crack in the No. 5 reactor

(Whittingham, 2005)

Human error analysis of the Flixborough disaster

Cause	Description	Type of error or other failure	Systemic cause or preventive action
Direct cause	Failure of the 20 inch bypass pipe causing a massive release of cyclohexane vapour to the atmosphere	Operator error (implied)	Since the inquiry was unable to establish a definitive cause (only the one with the highest probability), then by implication, the direct cause had to be over-pressurization of the system by the operators at start-up.
Root cause	The cause of the 20 inch bypass failure was either:		
	Over-pressurization during start-up or,	Management error	Inadequate design and support of the bypass pipe in a dog-leg configuration due to lack of mechanical engineering expertise.
	Mechanical displacement of the bypass pipe by slugs of liquid carried forward from reactor No. 4	Design error	A failure on the part of the designers to recognize or communicate the consequences of not operating the reactor stirrers at start-up.
Contributory causes	Failure by local management to understand the hazards of the cyclohexane process	Management error	This knowledge might have prevented the expedient construction of the 20 inch bypass pipe, due to the perceived hazards of a large unconfined vapour release.
	No qualified mechanical engineer on-site	Management error	Changes to a design should be overseen and authorized by properly qualified personnel.

PREVENTING DISASTERS ?

Process Safety related Disasters and Learning from Failure

Idea of technology:
design-based safety; then add-on safety

Technology should perform its function without fail.

But this is not always the case, due to various reasons!

Kletz and others report the same accident type occurring over and over again in the chemical industry, even sometimes in the same organization.

→ Even if ad hoc learning is occurring, it is not enough!

Process Safety related Disasters and Learning from Failure

- Therefore developers must struggle **to design in such a way as to avoid any failure**.

- Especially **to avoid catastrophic failure** which could result in major damage to the environment, loss of property, and injury or loss of life.

- **How can this be done?**
  Through analysis and study of technological disasters, modern technology designers can learn what not to do and how to create designs with a greater resistance to failure.

Some essentials

- Incidents and accidents should be adequately reported! (‘no blame’ culture, ‘just’ culture,…)
- Accident investigation should be adequate (objective and complete)! (9 elements of acc invest. Program: see book p.230)
- Management should always act upon accident investigation reports’ recommendations!
- A Company Memory should be installed in any organization!

Causes of process safety related catastrophes

- Human factor errors (e.g. Chernobyl)
- Inadequate training of staff (e.g. Three-mile Island)
- Technological design factors (e.g. Buncefield)
- Organizational systems factors (e.g. Texas City disaster)
- Socio-cultural factors (e.g. Bhopal)
- Technological terrorism (e.g. attacks on process installations, in Nigeria or Iraq)
- Materials failures / lack of engineering knowledge (e.g. Flixborough disaster)
- Extreme conditions or environments (e.g. Hurricane Katrina impact on process industry)

- and most commonly combinations of several of these reasons

Engineering Disaster Assignment (max. 2 pages, 1A4)

- Pick an example of an engineering failure/disaster of some type, i.e., nuclear power plant incident, plane crash, building collapse, chemical disaster, etc., preferably which has occurred in the last ten years.
- Describe it in some detail, and discuss what issues might have been at least partially responsible for the failure.
  In other words, create a failure analysis report for this failure that includes:
  - What failed.
  - Why it failed.
  - Possible corrective actions (How to make it not fail).
  - How to put this into a Company Memory.
  - Reflect on the ethical aspects involved

Crisis Management

- "Crises only happen to others"
- "If that should happen, we will improvise"
- "A crisis is unpredictable, so why should we get organised?"
- "People always exaggerate the severity and the consequences of a crisis"
- "We are in a crisis every day and we always get out of it"

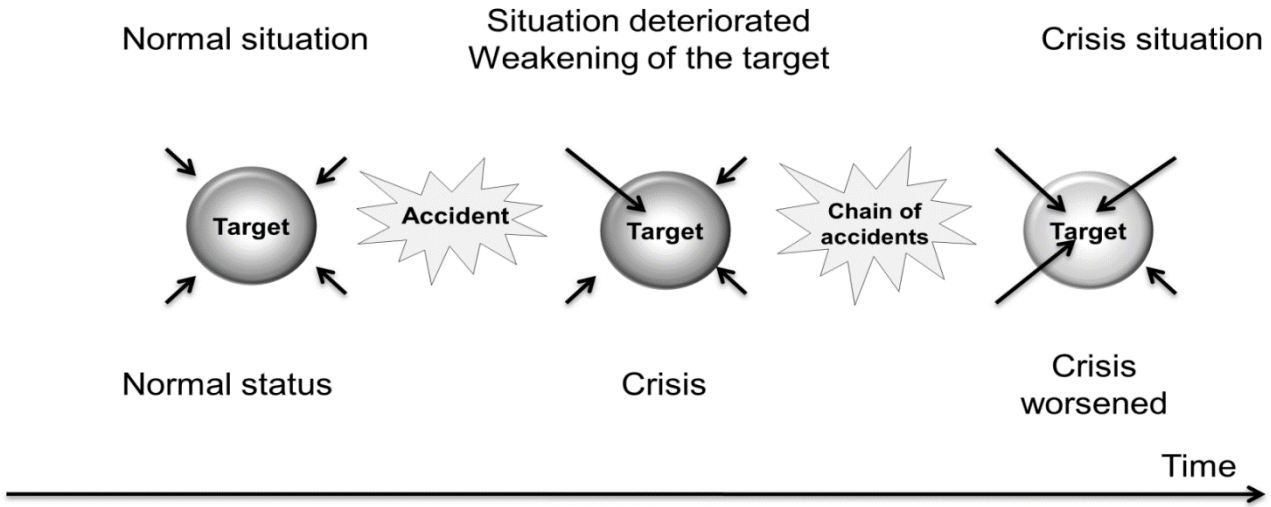
Nonetheless: "**UNSAFETY IS PATIENT!**"

Crisis characteristics

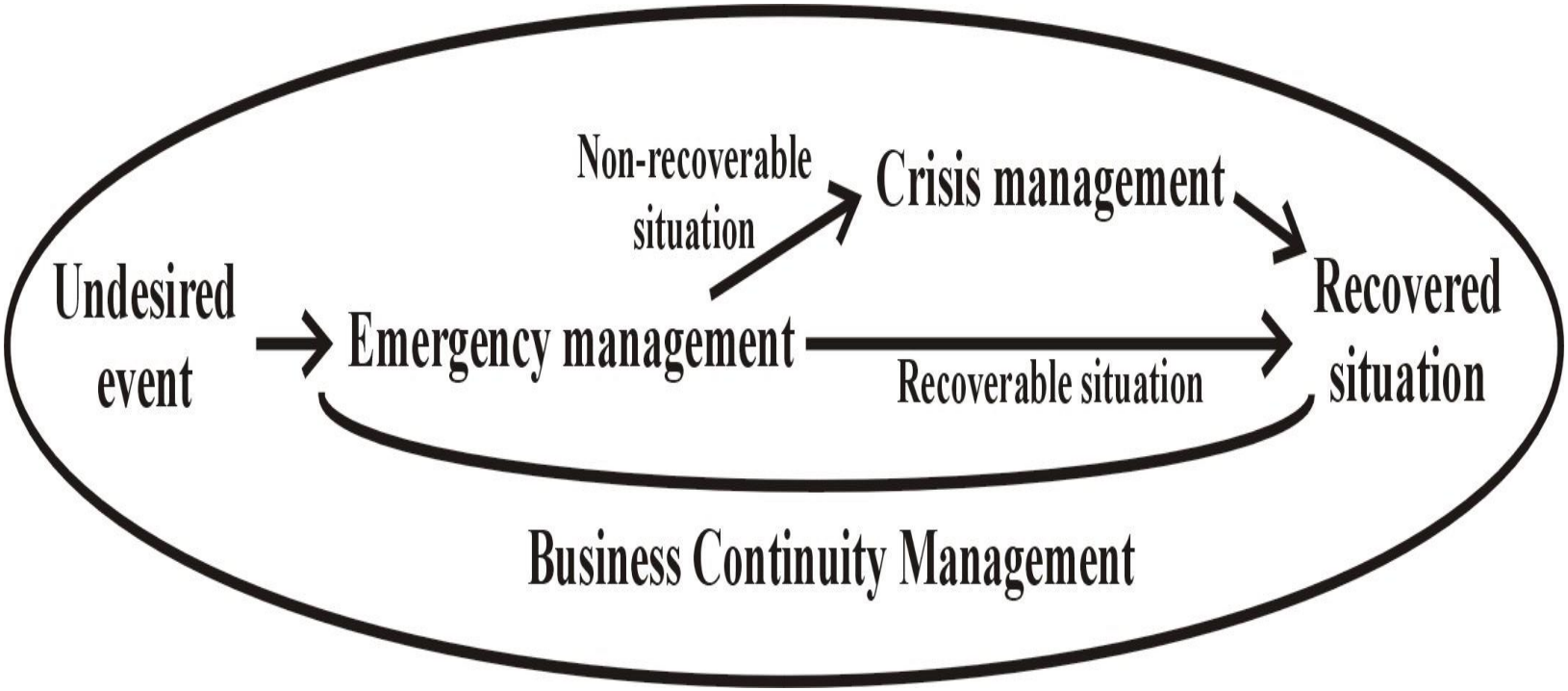
- **Surprise** - Even naturally occurring events, such as floods or earthquakes, do not escalate to the level of crisis unless they come at a time or a level of intensity beyond everyone's expectations.
- **Threat** - all crises create threatening circumstances that reach beyond the typical problems organisations face.
- **Short response time** - the threatening nature of crises means that they must be addressed quickly. This urgency is compounded by the fact that crises come as a surprise and introduce extreme threat into the situation.

A crisis is a specific, unexpected, and non-routine event or series of events that create(s) high levels of uncertainty and that is(are) threatening. You cannot manage a crisis the same way as another event.

Physical representation of a crisis



Exceptional, Emergency, Crisis



Some tips as regards crises

A crisis is often defined as an acute situation, hard to manage, with important and lasting consequences (sometimes harmful). It can result from a triggering accident or from the normal evolution of a situation. It has the following rules:

- Being unprepared is no excuse.
- You know the threats – get ready for them.
- Know in advance before you are asked.
- Admit that you are wing-it-challenged.
- Adopt short key message communication type.
- Beware of the court of public opinion.
- The first 72 hours of any crisis are crunch time.
- Do not forget that in crisis situation time flies.
- Get every help or support you may need.
- Every crisis is an opportunity.

Anticipating and preparing for a crisis is answering the following questions:

- How to react and be organised to face an unpredictable disaster?
- Which crisis management device should be deployed?
- Which collaborators should be implicated? What should they be attributed and what would their responsibilities be?
- Which logistics should be planned?
- Which crisis communication should be put into place? And for which addressees?
- Which procedures and which operation should be implemented to reduce crisis impact and proceed with the restarting of the activities?

Crisis catalysts

- Pressure groups
- Media (classic + new/social)
- Rumours
- Reaction of economic market (negative opinions, cfr. Social media)
- Intervention (of dept. of justice e.g.)
- Internal protest

Handling of crises

1. Preparation: **<u>before</u>**, it is composed of:

- **Major risk identification** (linked to strategic impact risks, necessitates risk quantification, focuses on critical consequences)
- **Prospective crisis organisation** (crisis scenarios and continuity plans, crisis levels, ethics and image). In case of a crisis, one can be confronted to ethical problems. It is possible, for example that some resources have to be sacrificed in order to save others.

Handling of crises

2. Treatment and repair: **during**, it is composed of:

- ***Triggering of the crisis*** (it is a matter of wisely triggering the crisis management process. If it is done too early, the system is destabilised, credibility is lost and we risk being no longer capable of mobilisation if the situation really requires it. Too late and the consequences will be dramatic).
- ***Crisis cell*** (the establishment of a crisis cell cannot be improvised at the last moment, but should be prepared, the members of the cell having previously participated in one or more simulations). The crisis cell has the mission of evaluating the disaster, taking immediate protection measures for people and the affected facilities. It must also inform the board of directors and the local authorities assure communication and determine a strategy to get back to a normal situation. The crisis cell is an emergency organisation of the service leader to identify a problem, put a contingency plan into action and return as quick as possible to a normal situation.
- Cfr. OSR: https://www.osr.be

Handling of crises

2. Treatment and repair: **during**, it is composed of:

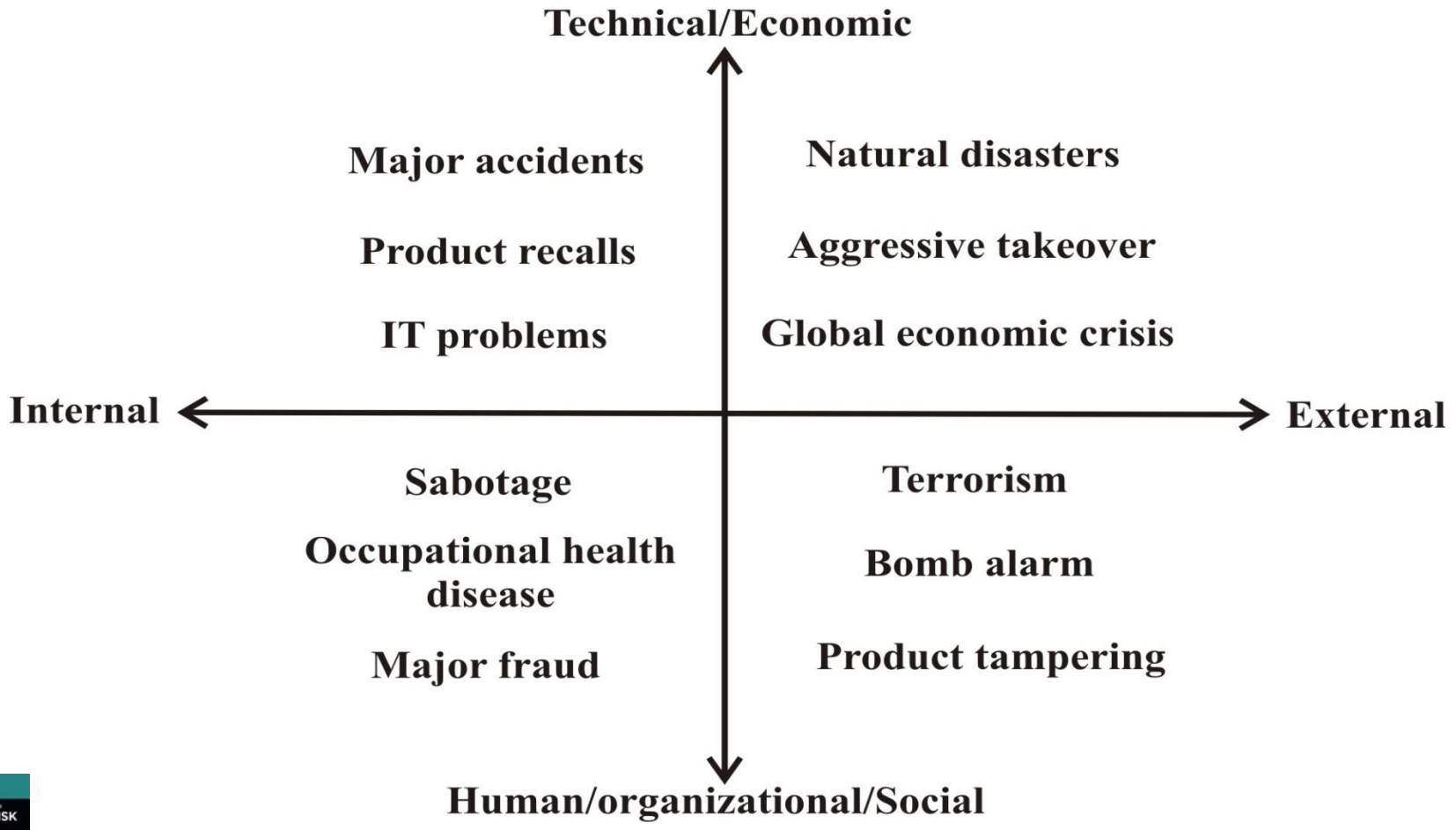
- ***Crisis communication*** (should be prepared, the possible attitudes, the choice of speech and tone of the message to send out are predetermined in the crisis scenario). It takes care of the relationship with the media. One will note that the media are: quick, simplifying, aggravating and amplifying.
- ***Repair*** (once the crisis reaches its peak and is in its descending phase, repairs can begin). The period preceding the crisis has been able to put into place temporary solutions. Repairs do not stop at these solutions and have the mission of returning back to normal.
- ***End of the crisis situation*** (the crisis situation has an end, it is thus necessary to record it). It enables one to put an end to the emergency and surveillance devices which have been put into place in parallel with the crisis. It is a subtle balance between taking the devices away too fast and leaving them in place too long.

Handling of crises

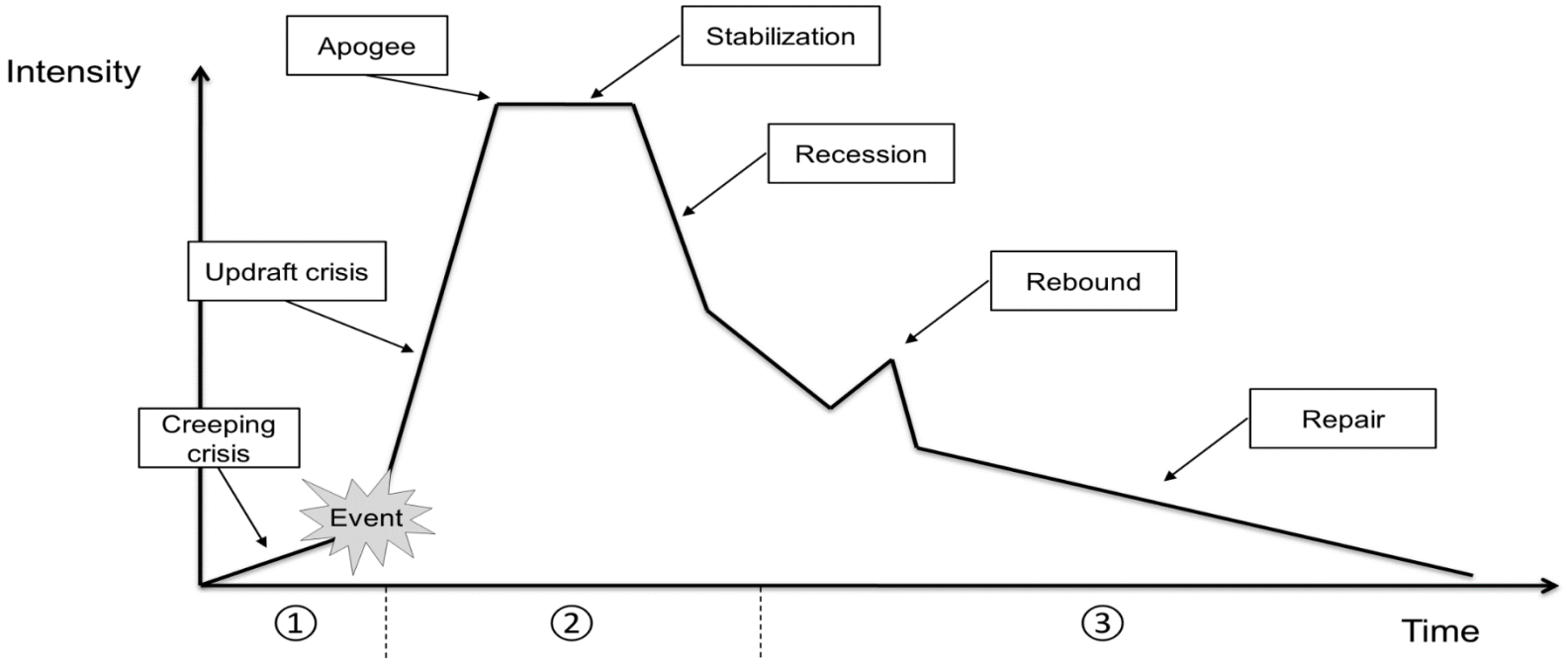
3. Memorisation: **after**, it is composed of:

- ***Learning*** from the situation, documenting and analysing the different steps and sequences.
- ***Feedback***, learn from the situation and improve a new occurrence.
- ***Continuity plan updates*** in order to learn from experience.

Types of crises to be handled by organizations



Crisis evolution



Media pattern in crises

- Press as news organ: guesses, estimates, corrections (cfr. Cobalt accident in Umicore in Febr. 2014)
- Press ‘anchors’ the crisis: a lot of attention, lack of material, comparison with other crises
- News becoms news: own role of media
- Media are organized: more info on disaster, what if…
- Journalism as ‘one of the powers’: felicitations to the media
- Media question themselves
- Disaster anniversaries

Do not forget: a concentration of journalists…

- At the location of the disaster
- In the crisis centre
- Telephonic
- With the outside world (external experts, neighbours, ex-employees, pressure groups, etc.)
- Internal (regular + whistleblowers)

6-hour method

- Hour 1
  - Decide crisis cell location
  - Provide internal guidelines
  - Organise logistic support
  - Composition of crisis team / crisi comm. Team
  - Definition of problem and approach
  - Announcement of a press contact in Hour 4
  - Difficult timing

6-hour method

- Hour 2
  - Screening and output
  - Determine strategy
  - Consulting within crisis team
- Hour 3
  - Internal briefing
  - First contact with stakeholders
  - Follow up of decisions

6-hour method

- Hour 4
  - Press conference
  - Continuous data collection and decision-making
- Hour 5
  - Announcing of regular briefings
  - Second contact stakeholders
- Hour 6
  - Additional explaining
  - Evaluation

Business Continuity Plan (BCP)

1. *Readiness:* Address the preparatory steps required to provide a strong foundation on which to build a BCP

2. *Prevention:* Address those areas where good planning will allow an organization to avoid, prevent, or limit the impact of a crisis occurring

3. *Response:* Develop the steps that will be required to respond effectively, appropriately, and timely should a crisis occur

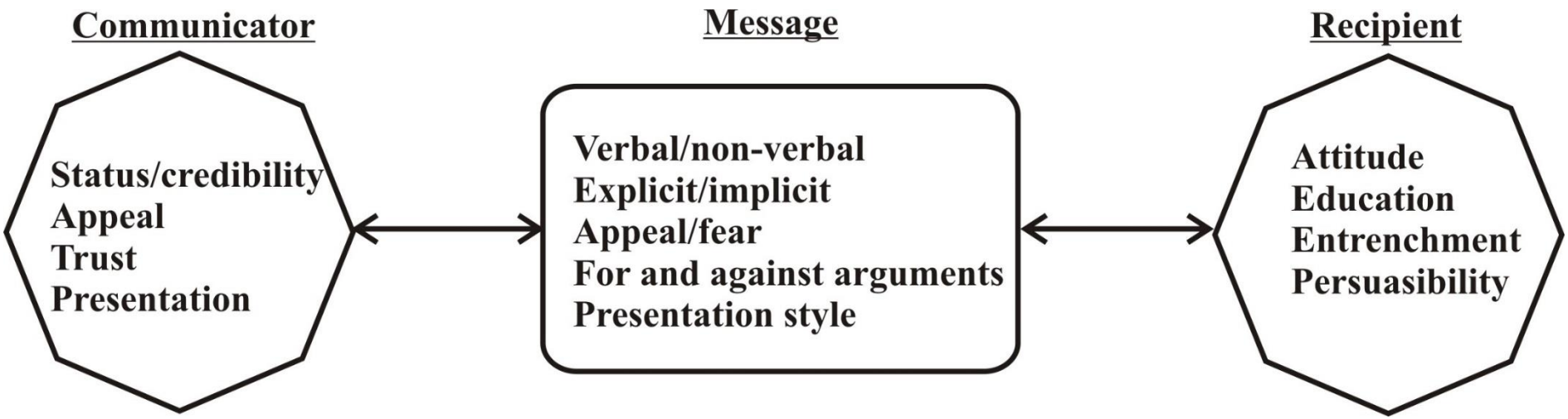
Business Continuity Plan (BCP)

1. *Readiness*
2. *Prevention*
3. *Response*

4. *Recovery and Resumption:* Develop policies, procedures and plans to bring the organization out of the crisis, recover/resume critical processes, and finally return to normal operations

5. *Test & Train; Evaluate & Maintain:* Train and educate team members, as well as general employee population, and validate and enhance the BCP

Crisis communication



The risk communication process

Definition: an interactive process of exchange of information and opinion amongst individuals, groups and institutions.
The approach involves multiple messages about the nature of the risk.

= complex process of communication, since the process depends on the actual and perceived characteristics of the communicators, the messages communicated, and the recipients.

Main problems:

- Presenting scientific risk data
- The competence of risk communicators
- The media reporting techniques and procedures for communicating risk issues
- The public's ability to evaluate and interpret risk data

The risk communication process

4 possible reasons for effective risk communication:

- A desire by government and industry to inform the public
- A desire by government and industry to counter public opposition
- A desire by government to present a power-sharing process with the public
- A desire to improve the process of regulatory control

Important points to consider:

- *Level of fear*

- *Emotive impact (avoid making comparisons, discuss a full range of risk mitigation options, identify the benefits associated with the risks and balance them against the known costs)*

The risk communication process

Risk communication strategies: 3 approaches:

- *technical approach: dissemination of technical information about a hazard and its associated risks as the main theme of the communication process. Presentors: scientists and engineers. Information is presented in a factual way with little or no discussion with other stakeholders*

- *public relations approach: concentrates on getting the 'right message' across the stakeholders. Little effort to educate or increase the stakeholders' understanding of the issues involved.*

- *multidisciplinary approach: aims to take the positive aspects of both previous approaches to combine them with other relevant disciplines such as toxicology, social sciences and economics, in order to present a holistic approach*

Communication strategies

1. Apologize
2. Corrective strategy
3. Crisis not denied, but no responsibility taken
4. Justification
5. Strategy of deterrence
6. Denial
7. Attack

Communication hints (1)

- Provide relevant answers and arguments
- Know what you are doing (and saying)
- Provide a personnal approach
- Build up a good and professional image
- Communicate in a pro-active way
- Establish prior to any crisis a basic communication (strategy)
- Opt for communication instead of lawsuits
- Don’t blame others
- communicate constructively - no polemic

Communication hints (2)

- finish
- Provide a consistent message
- Show compassion
- Prepare for the worst (and the worst questions)
- Prevent escalation
- Provide attention to all forms of communication
- Always be aware of what you say or do, also if there is not a crisis at all
- Search for allies
- Don’t only assess the facts, but also the emotions

Communication hints (3)

- Provide as many details as possible/feasible
- Comfort (assure people)
- Say what will be done about the problem
- Stress the good reputation of the organisation
- Communicate where and when there will be more information provided
- Provide eventually for free phone numbers, help lines, etc.
- Provide backup information
- Don’t forget to look after internal communication as good as external communication

Trust and risk communication

Characteristics of the risks are also important:

e.g. concerning environmental risks, information provided by pressure groups is trusted more than private companies (Japan – whale hunting)

Losing trust is easier than winning trust for communicators (e.g. chemical companies)

Natural bias from the public towards distrust (asymmetric principle), as a result of:

1. Adverse events are more visible than beneficial events, as they are more likely to attract media attention

2. Negative events inevitably exert a greater influence on one's views than positive events

Trust and risk communication

3. Public perceive bad news as more credible than good news

4. Bad news reinforces the public's existing distrust (eventual bias); good news does not take away existing fears about hazards

Levels of trust given to different functions/professions:
Most trusted – least trusted

Distrust often is a result of misunderstanding from the people that a risk assessment equates to the removal of all risk rather than to the definition of a level of residual risk: an accident can still be within the pre-defined envelope of tolerable levels of risk!

Trust and risk communication

4 key issues that communicators should address in order to establish trust among stakeholders:

- Create empathy by engaging with the audience
- Demonstrate concern for the people and their issues
- Provide evidence of commitment to dealing with the issues
- Explain the benefits that are associated with the risks

Risk communication exercise

- “The interview”: you are the prevention advisor who is interviewed concerning a major incident. A LOC of a chemical has happened with one of the storage tanks of your plant.

- Try to answer correctly without causing fear.

Emergency planning in practice

Multi-disciplinary: 5 disciplines (max):

- Medical (medical aid)
- Fire brigade (fire extinguishing and rescue working) (Coordinator, mostly; Cp-Ops)
- Police (protection and law enforcement)
- Civil protection (logistics)
- Information and communication

  (press informing, social media, etc.)

Coordination

CP-Ops	Commandopost-operations
CC	Coordination comittee
CC-Gem	Municipal Coordination comittee
GCC	Municipal Crisis center (= location)
CC-Prov	Provincial Coordination comittee
PCC	Provincial crisis center (= location)
CGCCR	Coordination- & crisis center of the Government
VMP	Advanced Medical Post

Organisation intervention area (‘Triage’):