IMPROVING RESILIENCE OF CRITICAL HUMAN SYSTEMS IN CBRN-EMERGENCIES: CHALLENGES FOR FIRST RESPONDERS

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ABSTRACT

Today's catastrophes (many of them man-made or at least triggered by human activities) usually endanger a growing number of humans and larger areas in more diversified ways, creating a need for dependability and resilience of our environment. Experience tells us that no matter what precautions and quality approaches we take we will always encounter systems which initially were dependable and 'suddenly' turn untrustworthy due to some unexpected, unknown cause. A system which in itself is unable to reestablish its dependability, i.e. it is not rewsilient (any more) needs an *outside intervention*: For humans a physician acts as an intervention system for re-establishing dependability. A complex system can be made resilient by the inclusion of an Intervention System which intervenes in the case of loss of dependability.

In this paper we investigate the role of First Responders (i.e. fire brigade, ambulance services, police forces) as an Intervention System in the case of CBRN-incidents, aimed at providing resilience. Taking a process view of such interventions we analyze key processes especially with respect to supporting them by Information and Communication Technology. We identify properties of CBRN incidents and their implications for the activities of First Responders both in training and real assignments.

Keywords: First Responders, CBRN-emergencies, process modelling, resilience, dependability, intervention system, simulation, Mixed Reality

1 MOTIVATION

Natural and man made catastrophes have always threatened people. In the last decades awareness, concern and the occurrence of actual catastrophes (many of them man-made or at least triggered by human activities) has grown.

There are numerous reasons for that: Land is more densely populated, as a consequence people live also in areas where centuries ago nobody would have wanted/dared to live. Today's catastrophes usually endanger a growing number of humans and larger areas in more diversified ways. Human interference with nature weakens and/or eliminates nature's safety provisions and natural buffer mechanisms (e.g. land for inundation, protective forests, ..) Failures of technical artefacts cause severe catastrophes (Chernobyl in 1986, an exploding oil rig in the Mexican gulf in 2010, ...). Many of our technical 'achievements' are more efficient but often at the cost of reduced robustness (computer chips and solar eruptions, ...). Global interconnection and dependencies increase the impact of somewhat local disturbances (volcanic ash and air traffic, ...).

The Media compound to certain extent the catastrophes by reporting with sensational information ('bad news are good news'). The immediate availability of information across space and time and with considerable visual detail increase awareness and often cause inadequate reactions of humans, The advances of ICT have created a large number of complex critical embedded systems. The need for dependability of such systems is heavily growing in our times

Computer support on the one hand enhances the dependability of critical systems by eliminating human shortcomings but on the other hand it threatens dependability by eliminating human common sense reactions in case of difficulties. Computer systems often exaggerates the effects of an unreliable system.

2 DEPENDABILITY, RESILIENCE AND SYSTEMIC INTERVENTIONS

2.1 Dependability

In general we want to be able to 'rely on' the systems in our environment that they behave in predictable and acceptable ways. We notice that Mother Nature is very good at maintaining dependability.

Dependability is a complex property. As a compound term "dependability" consists of availability, reliability, safety, security (confidentiality, integrity, authenticity), maintainability, and survivability. The exact semantics of some of these words is still under discussion (Chroust and Schoitsch, 2008; Schoitsch, 2008, 2009; Laprie et al., 1992).

Many of the problems with dependability result from the complexity of the involved systems, also characterized as *wicked systems* (Kopetz, 1997) or *critical systems* (Cooper, 2003; Jackson, 2003). Experience tells us that no matter what precautions and quality approaches we select we will always encounter systems which initially and hitherto were dependable and 'suddenly' become untrustworthy due to some unexpected, unknown cause.

One reason is often emergence (Brunner, 2002; Emmeche et al., 1997). Emergence is an elusive notion. It denotes properties which are not present in any of the system's subsystems and only appear due to some specific structural properties of a system (Baas and Emmeche, 1997; Pessa, 1998). We define (Chroust, 2002, 2004): An emergent property of a system is a property which is not determined solely from the properties of the system's components, but which is additionally determined by the system's structure (i.e. by the way the parts are connected to form the system).

In other words some external or internal disturbance causes an (assumed) dependable system to go into a failure state in which it does not fulfil the expected dependability criteria.

2.2 Resilient Systems - a Systemic View

In (Francois, 2004, p. 504) we find the following definition of *resilience*: *"The capacity of an adapting and/or evolving system to bounce back to dynamic stability after a disturbance. In a more general meaning, resilience includes the system's ability to create new conditions of fitness for itself whenever necessary"*. Amnd further on, citing (Holling, 1986): *"The size of the stability domain of residence, the strength of repulsive forces at the boundary, and the resistance of the domain to contractions are all distinct measures of resilience"*. [A system] has *"the ability ... to absorb changes of state variables, driving variables, and parameters, and still persist"*.
A resilient system is expected to be able to survive an external disturbance and remain in a dependable condition. The concept of resilience is related to the concept of autopoiesis (Maturana and Varela, 1980; Maturana, 1981) and usually involves strong cybernetic properties (feedback loops!).

2.3 Establishing Resilience via an Intervention System

If a system by itself is unable to reestablish its dependability (i.e. that the external or internal disturbances go beyond its stability boundary) an *outside intervention* is necessary. Typically a human falling ill goes to a physician in order to get some medicine and/or treatment. Thus the physician acts as an external system for re-establishing dependability. A system can be made resilient by combining it with a *Compensation System* which intervenes in the case of loss of dependability of the original (sub)-system and ensures that the system remains dependable (fig. 1). The Compensation System is assumed to be able to handle the dependability problem *internally* such that the system offers itself as dependable to the outside world. In systemic terms the Compensating System provides the necessary requisite variety (Ashby, 1956) for the total system to remain dependable.

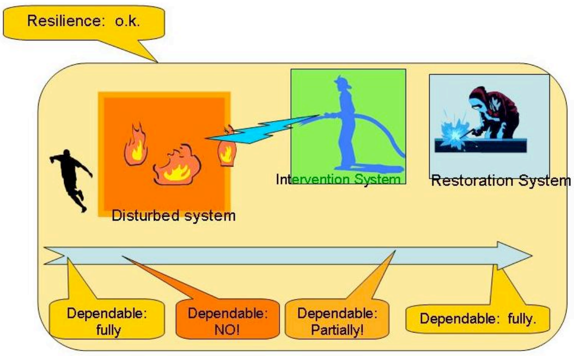


Fig. 1: Creating a resilient system by a Intervention and a RestorationSystem

A closer investigation of actual emergency situations in our civilization shows that actually it is of advantage to split the *Compensating Systems* into two systems (fig. 1):

the Intervention System for quick first responses (e.g. 'First Responders') and

the Restoration System for longer term restoration of the original system.

The tasks for these two types of tasks differe considerably. They have different aims, purposes and as a consequence, time and efficiency requirements. In systemic terms (cf. fig. 1) in order

to (re-)establish short-term dependability we introduce an Intervention System responsible for immediate, quick response (Chroust et al., 2009a). Additionally we foresee a Restoration System charged with transforming the system into a more acceptable state which promises long-term dependability. The Restoration System does not have the burden of providing a speedy reaction. Here efficacy, efficiency, long-term considerations take priority and the members of these systems will be specialist, while the actors in the Intervention System usually will be generalists.
As a consequence, systemically seen, the total system is dependable before and after an incident (if the Intervention System is successful) with some transition period where dependability is not guaranteed.
Very early in the human history it was recognized that specialized organizations were needed for eliminating or at least mitigating the negative impacts of the disturbances. Already in 23 BC the Roman Emperor Augustus established an organization of full-time, professional fire fighters (*vigiles*).

3 CBRN-INCIDENTS

3.1 Characteristics of CBRN-Incidents

CBRN-Incidents, where chemical, biological, radioactive, or nuclear causes are involved have often considerably different properties as compared with other incidents (Chroust et al., 2008). As a consequence the Intervention Systems might need completely different approaches from classical interventions and incidents.
Some of the properties which have to be considered are (Chroust et al., 2008):

- The immediately apparent symptoms will often not be indicative, some of the symptoms will emerge seemingly spontaneous without any fore-warning.
- The dangerous material is in most cases a **pollutant** (Wikipedia-english, 2005, keyword=Hazardous-materials). It is usually kept in a **container** and more or less secured against spilling, evasion or harming the outside world.
- Involved materials are often of high toxicity. They often gravely endanger the rescuers, especially First Responders, who might be ignorant of the true cause and type of emergency.
- Some substances are prone to be distributed by meteorologic/geologic events or agents (e.g. wind, water, and weather).
- Sometimes emergencies are the result of a careless, negligent action (e.g. Chernobyl).
- They could also be the result of malicious (e.g. terroristic) action, where the source of the incident etc. is hidden, camouflaged etc.
- Many incidents arise from semi- or totally automatic plants (e.g. a chemical plant) where human minds do not interfere early enough or where the speed of the development overwhelms humans.
- The critical incident could cause contamination of other persons and objects who/which themselves could become carriers of the same danger.

- Some of such emergencies endanger large areas and large populations with the danger of long-lasting consequences.

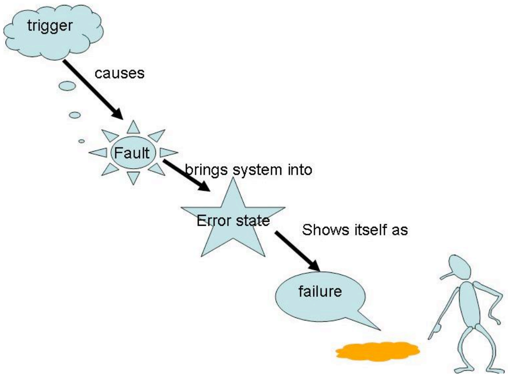


Fig. 2: From trigger to failure

Fig. 3: Testing contamination

Many situation leading to an emergency can be described as follows (Schoitsch, 1988), see fig. 2:

trigger : Some internal or external event (human, nature, chance, ..) causes a fault with respect to the pollutant's container.

fault : The fault is the actual reason/cause that the container goes into an error state. The fault could be a latent fault (very often due to software) or a newly emerging fault (for example the container breaks, becomes overheated, ...)

error : The error (state) is that state of the container which leads to a failure. In our case there is practically always some kind of pollutant (be it radiation, a bacterium or virus, or some aggressive toxic chemical substance) emanating into the environment. It causes risk/danger/damage to persons ('victims', First Responders) and/or objects.

failure : A failure occurs when the container deviates from its specification or expected behavior. Obviously the fault must change something in the state of the container (i.e. transfer it to the error state, causing a chemical reaction, raising radiation beyond an acceptable level, etc.)

Note that the failure must have some external effect, e.g. disperse radioactive water to the environment, leak some chemicals into the environment, etc. We do not speak of a failure, if no externally noticeable change happens.
From a systems point of view the identification of a failure is dependent on the *boundary definition* of the container.

3.2 Time-Evolution of CBRN-incidents

A very important aspect of catastrophes is their progression and evolution over time. A basic analysis with respect to the classification of catastrophe types can be found in (Mrotzek and Ossimitz, 2008; Mrotzek, 2009). Mrotzek defines a catastrophe as any event and development which leaves the domain of expected behaviour (grey zones in fig. 4), be it temporarily or permanently. He shows that the time dimension plays a key role in the analysis and evaluation of incidents.
Fig. 4 shows some typical time evolution of the incidents under consideration. A major distinction is obviously whether the catastrophe is reversible or not. Chemical incidents are often reversible, often to a different state however, accidents in atomic power plants have the risk of being not reversible, or only to a state which in itself is not very desirable (e.g. Chernobyl).

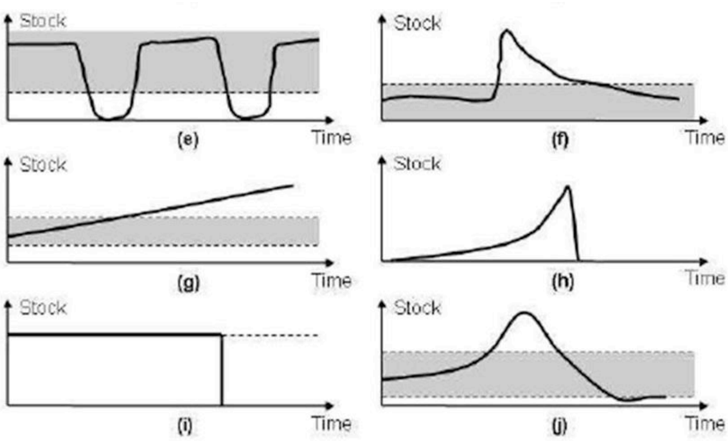


Fig. 4: Types of Catastrophes (Mrotzek and Ossimitz, 2008)

4 FIRST RESPONDERS AS INTERVENTION SYSTEM FOR CBRN-INCIDENTS

In the case of an incident First Responders will be the first ones to reach the location where the symptoms appear. One must bear in mind that this is not necessarily the location where the incident was triggered (cf. fig. 2) nor the location where the most effective intervention action could be taken.
With respect to the First Responders we can observe (Chroust et al., 2008):

- Humans do not posses any inborn, natural sensors to recognize CBNR dangers early enough. They are not equipped with natural, semi-autonomous reaction patterns.

- They need to be equipped with special tools to recognize/distinguish the dangers and the real sources. Special training is needed in order to operate these tools appropriately.
- Hazardous material must be recognized (ability to understand labels and markings!).
- Well trained and experienced emergency personnel are a key for a successful intervention.
- CBRN-incidents often show surprising immanent dynamic behaviour which is not easily and naturally recognized by humans correctly (e.g. exponential growth like a chain reaction).
- Many of these systems show a time-critical behaviour. Therefore correct tactical and strategic decisions have to be made based on available material, tools, and best practices.
- Such catastrophes have to be contemplated and approached considering many intertwined factors and subsystems.

From a broader perspective we can make several observations:

- More effective methods are needed as countermeasures and the interplay of several organizations of so-called First Responders, i.e. fire brigade, ambulance services, police forces become more important.
- A holistic, systemic approach to interventions is needed if we want to avoid additional dangers to life and property and a long term deterioration of the environment.
- The basic objective of an intervention by First Responders is to avoid complete loss of control of the system, i.e. to contain the system's behaviour and parameters within reasonable, acceptable boundaries such that with the help of an Intervention System the system can be made resilient to an acceptable status.

5 PROCESS VIEW OF INTERVENTIONS

In the case of an intervention many activities are performed. For analysis, improvement and training a clear identification of the individual processes and their interaction are of key importance, especially with respect to the key processes (Chroust et al., 2008). A process view facilitates preparation before an intervention, the enactment of the intervention during a real assignment, and the necessary activities after an intervention. It allows a detailed identification, analysis, and evaluation of key processes and as a consequence focused training possibilities (Chroust et al., 2008).

The application of this approach for interventions allows interesting and useful observations and conclusions, especially when considering ICT-support. Based on fig. 1 one can view the interventions of the First Responders as a network of processes, some serialized, some interdependent, some parallel to each other.

In analogy to (ISO/IEC, 2007) we can identify three classes of processes: Primary Processes, Supporting Processes, and Organizational Processes. Each of these process classes comprises several processes which in themselves comprise several subprocesses (see Table 1).

Table 1: SIMRAD Process Tree

Process Class	Processes
Primary Processes	Reaction to an Alarm In-situ Analysis Evaluation of Situation, Modelling Simulation Tactical and Strategic Decisions Actual Intervention
Supporting Processes	Communication Processes Accessing and Using Knowledge-Databases Utilizing Electronic Decision Support Accounting for Human Reaction Management and Coordination Considering Organizational and Cultural Differences
Organizational Processes	Training Reporting Human ressource development Failure Prevention Process Optimization Assessment of intervention processes

In more detail the processes are:

Primary Processes

The processes are the key to an intervention and comprise all ’essential activities’ which are commonly expected to be performed during an intervention.

Reaction to an Alarm This is the actual start of the intervention. One of the keys is the amount of information the caller has to/will/can provide. How can one solicit more information? Are there caller-independent sources of information (position of caller via GPS, position of telephone booth? etc.)
Essential sub-activities are:
accepting an emergency call, decision on trustworthiness and reliability of call, avoiding hoaxes, mobilize appropriate First Responder units, coordinate with other First Responder units

In-situ Analysis A serious problem in CBRN-emergencies it the lack of ’inborn’ human sensors for the danger. Even classifying an incident as a CBRN-emergency might sometime be difficult.
Essential sub-activities are:
recognize hazardous material, find location of hazardous material, analyze container of material, identify error state of container, analyze the total situation, estimate risks, recognize secondary and/or emergent dangers.

Evaluation of Situation, Modelling Building models of the identified facts and observations (heavily relying on ICT)

Simulation Based on the models one can sometimes perform (supported by ICT) simulation in order to gain insight into possible evolutions and possible alternative approaches of the intervention

Tactical and Strategic Decisions Having acquired a certain knowledge about the situation and its possible progression and the resulting consequences (from experience, supported by simulation) it is necessary to decide on the appropriate best practices of intervention, both for short-time immediate tactics and for longer-term strategies.
Essential sub-activities are:
causal analysis, risk assessment, choice between alternative approaches, choice of equipment, consider emergent and secondary effects. All these sub-activities use considerable ICT.

Actual Intervention Probably the most obvious need is to understand and learn Best Practices for 'technically' handling the individual emergency situations. This means mostly technical knowledge of how to behave and to act.
Essential sub-activities are:
help and treat victims, secure and protect objects, secure objects, handle secondary effects of the emergency, ensure safety and security of First Responders, termination of Intervention, hand-over to specialists (e.g. Restoration Team)

Supporting Processes Besides the key processes described above, which depend on one another and have to be performed in a certain sequence (but with iterations and refinement steps) there are global subprocesses which are used during the whole process.
Essential sub-activities are:
Communication (see also section 6.5), Accessing and Using Knowledge-Databases, Utilizing Electronic Decision Support, Accounting for Human Reaction, Management and Coordination, Considering Organizational and Cultural Differences.

Organizational Processes /commuOrganizational processes are usually employed outside the realm of a single intervention. They are concerned with long-term consideration. They consist of processes employed by an organization to establish and implement and improve the infrastructure.
Essential subprocesses are: Training, Reporting, Human resource development, Failure Prevention, Process Assessment, Process Optimization , etc.

The process view is useful to understand, analyse, and modify individuzal prcesess within a complex activity. A further chance is the possibility to *assess and compare* the quality of alternative intervention processes (Chroust et al., 2009a) and to use this as a source process improvements.

In the sequel we will discuss some of these processes in more detail, especially those which are specific to interventions by First Responders in CBRN-interventions.

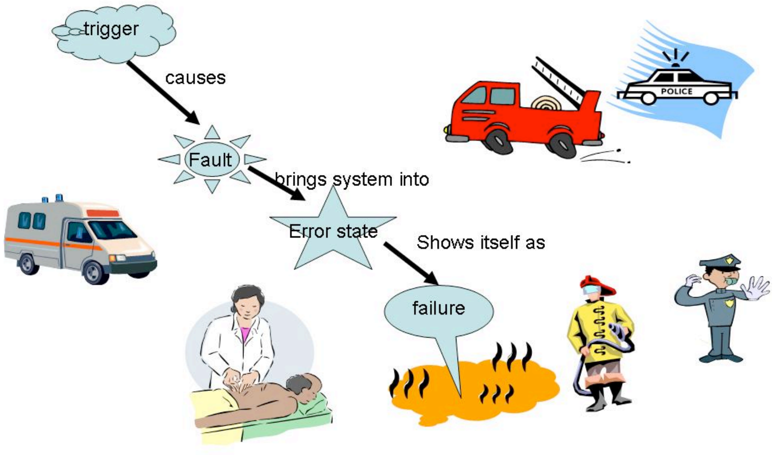
6 SPECIFIC INTERVENTION PROCESSES

In this section we will discuss some of the processes listed in section 5 in more detail. We will emphasize those processes which are of high relevance for First Responders in

CBRN-intgerventions and where the use of modern ICT is especially helpful to perform and improve these processes.

6.1 Analysis of Situation

Fig. 5 shows the steps from the actual trigger of the incident to the actual interventions caused by apparent symptoms. Obviously the identification of the cause of the disturbance (the fault) and it localiuzation is of high importance.



CBRN =
chemical, biological, radiological, and nuclear dangers

Fig. 5: First Responder

6.2 Visualisation

Given the usual invisibility of the CBRN-threats, it is essential to give the First Responders some means of still 'seeing' them. Fig. 6 shows the whole continuum from the unchanged real environment, various forms of enhanced environments to the completely abstracted representation (Chroust et al., 2009a) as provided by modern ICT.

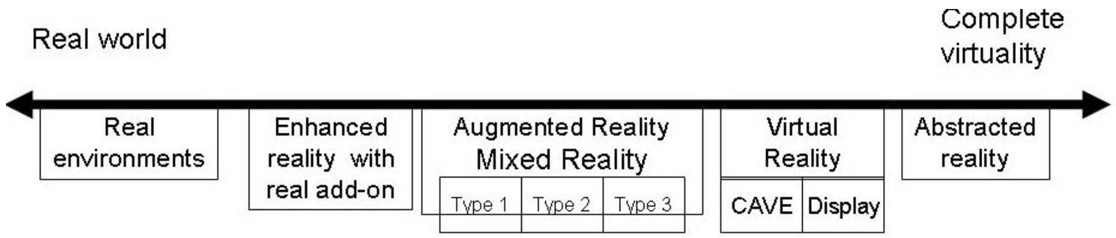


Fig. 6: Continuum from real world to full virtuality

We distinguish between:

- *real-world (non enhanced) environment*

- *real-world environment extended by physical objects*, e.g. added markers and signs (e.g road signs, flags, warning icons, etc.)
- *Augmented Reality* (Azuma, 1976, 2004), also called Mixed Reality. It is characterized by
  - – combining real and virtual images,
  - – being interactive in real-time, and
  - – being registered in three dimensions.

  we can distinguish three subcategories (Chroust et al., 2009b):

  Type 1 : The information is generated at the viewer's location and is electronically attached (projected) on the real-world object and thus can be seen from everywhere, at any angle, etc. . It does not need a specific outfit of the viewer..

  Type 2 : A computer generated image is locally superimposed (e.g. on glasses of the viewer) partially covering the distant object. This is usually achieved by appropriate semi-transparent glasses (fig. 7). In this simple case the picture in the glasses is NOT correlated to the position of the object. It is useful to provide general information without the need to be directly linked to the object.

  Type 3 : A computer generated image is superimposed (e.g. on glasses of the viewer) and correlated with the real object. This more useful, sophisticated, and expensive version needs information about the relative position, viewing direction etc. of the user with respect to the real objects and has to reflect changes in position of both the object and the user (cf. fig. 7).
- *Virtual Reality*: a locally created image on an appropriate presentation means without any correlation to the real world around.
- *Complex Mathematical Simulation Models* (=abstracted virtual reality), completely abstracting from any resemblance to the reality and just providing mathematical models (e.g. System Dynamics Models).

For the purpose of First Responders in the field the various forms of Augmented Reality seem to be most useful.
Obviously Augmented Reality of Type 3 offers the greatest computational challenges. Augmented Reality Systems need to have subsystems for pattern recognition, image recognition, recognition of features, often enhancements of light (infrared, night view) etc.

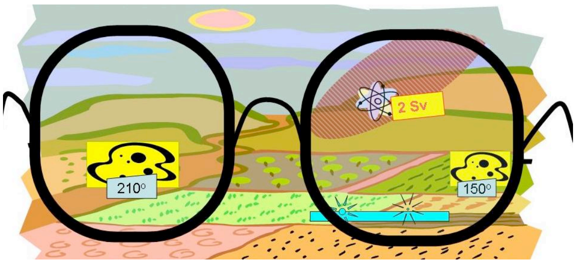


Fig. 7: Augmented Reality - adding information in glasses

6.3 Modeling and Simulation

The process view makes it possible to create precise descriptions of the individual steps necessary in an intervention together with their sequencing and interdependency constraints. This provides the basis for static analysis (e.g. walk-through), for theoretical considerations, and for dynamic enactment (simulation) of these individual steps.
A key to a process view is *modeling* of the processes in sufficient detail in a formal way. Scientifically one defines a *model* as an object which allows to draw analogue conclusions about another object, the *original* (Hilty, 1989). Every model is an abstraction (Luft, 1984) which usually describes in a simplified form some properties of the original. The chosen form of description has considerable influence on the usefulness of a model.
Simulation can be defined as the *reproduction of the dynamical behaviour of a real system using a (real) model to arrive at conclusions which are applicable to the real world* (Pichler, 1992, p.239). It is a proven method for training and planning (cf. flight simulators) by *dynamically* enacting certain processes and (in many cases) allows interaction with the user. Simulations have many advantages. Being dynamic they provide an illustrative view of how a process proceeds allowing often to detect incompatibilities and irregularities in a process description which are not obvious in a static analysis of the process model. Simulations can be repeated with different parameters and influence factors, they are controllable, they allow to record the individual steps, repeating certain sequences, evaluation, etc. (Chroust et al., 2009b; Rainer et al., 2009; Sturm et al., 2009).
Depending on the type of model, different variations of simulation can be performed, ranging from abstract mathematical equations to views as provided by Virtual and Mixed Realities, the latter allowing the combination with the real environment (see section 6.2).

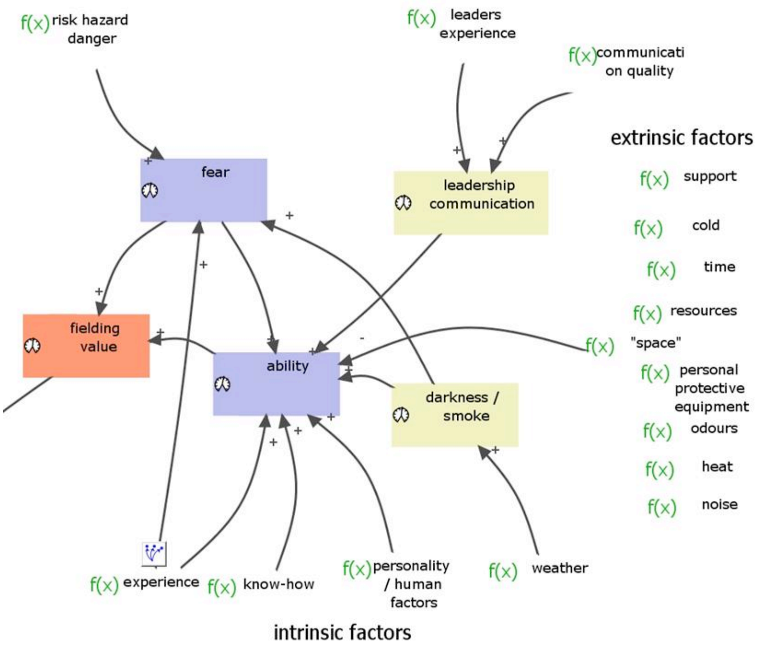


Fig. 8: The Consideo model of First responders

In order to understand quantitatively the effect of the enactment of a process various mathematical dynamic modelling tools exist. System Dynamics (Pfahl, 2005) is a discrete approach to dynamic modelling. It models the movement of individual elements through the system, typically like in a factory. Numerical values (duration, size, ...) characterize the behaviour of the elements in the system and the changes done to them. Examples could be the number of First Responders, their time consumption for various activities (helping an injured person). Based on a system run one can detect the throughput of a system (e.g. the number of victims treated, the number of First Responders in a certain location, etc.). Powerful simulation tools are ARENA, POWERS, VENSIM etc. Fig. 8 shows (in System Dynamics Notation) how the various external influences impact the abilities of First Responders when performing an intervention.

6.4 Access to Information Repositories

First Responders must have available own knowledge to evaluate the applicability of the appropriate Best Practices. Additionally they must be able to request ad-hoc and just-in-time additional information on the specific situation (fig. 9). Basically the information can be available in several forms:

- internalized know-how of First Responders (implies *training before* the intervention!)
- communication with other First Responders, commanders and officers-in-charge, etc.
- communication with stake-holders and victims
- access to external (back-up) know-how (manuals - can they used in these circumstances? - or wireless communication with data base)

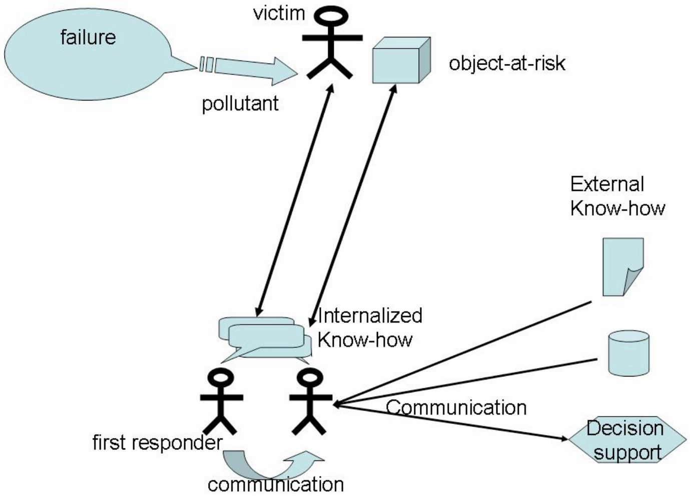


Fig. 9: First Responders' information need

6.5 Communication

A key to a successful intervention is obviously the communication between different First Responders, with their common command group, even across organizational boundaries. Coordination and team work cannot be achieved without communication.

In many cases direct communication might be hampered or obstructed by physical (noise, smoke, visibility), or physiological gaps (hard hearing, ...) or cultural barriers (language, taboos, ...). Fig. 10 sketches all the various influences which potentially create gaps in communication. A fuller discussion can be found in [Chroust-08zc].

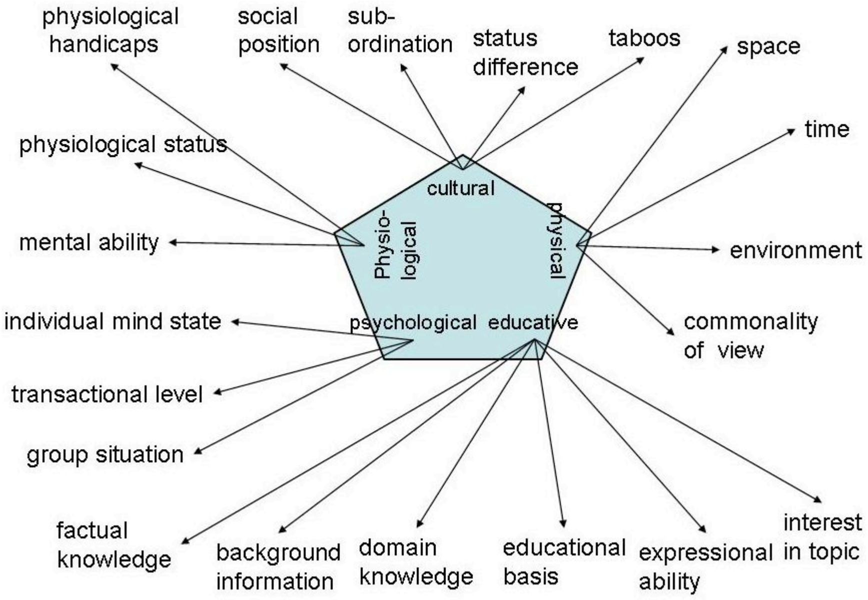


Fig. 10: Dimension of gaps in coommunication

Key subprocesses are:

- communicate with your co-responders
- communicate with victims
- communicate with central coordination group
- communicate with information sources (knowledge data bases),

7 IMPLICATIONS FOR TRAINING OF FIRST RESPONDERS - THE SIMRAD-PROJECTS

In the case of an intervention professional emergency response groups (e.g. fire brigades), rescue units (e.g. Red Cross) together with appropriate security organizations (police, military), specialists (e.g. laboratory personnel), and also voluntary helpers are in charge of handling the emergency situation, to take appropriate rescue actions, and to minimize the negative effects.

A serious problem with respect to these dangers is that usually we do not have any inborn, natural sensors to recognize them, let alone natural, semi-autonomous reactions. Adequate training is therefore of high importance for properly operating the equipment, making the correct interpretations of the results, drawing the correct conclusions, and initiating the appropriate reactions.

It is necessary to get the required practice in handling tools, setting correct measures and to assess the situation and its potential dangers. One must also identify, design, validate and train appropriate behavior (Best Practices) to counteract the dangers. These Best Practices might be counter-intuitive and, if not well chosen, might negatively interfere with one another (again an area for validation).

Modern ICT allows today to provide a training environment with simulated and mixed scenarios (Augmented Reality) which are flexible and cost effective (Chroust et al., 2008). Simulation is a highly useful training means, especially when the training cannot be performed in the real environment, which is true of most CBRN incidents (Chroust et al., 2009b; Rainer et al., 2009; Sturm et al., 2009). Virtual Reality and Augmented Reality are one of the key means to achieve training success.

The obvious advantage is that realistic environments allow hands-on training which for many situations is a key to sustainable learning.

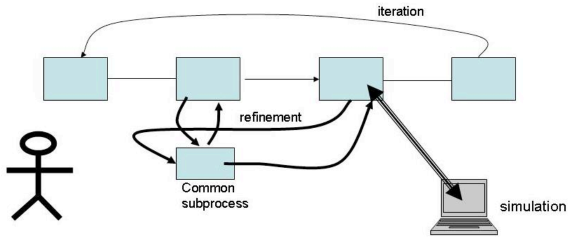


Fig. 11: Substituting real-world processes by simulated ones

Fig. 11 indicates that one can substitute some processes of an intervention with simulations while others are executed in the real environment. Useful applications are the replacement of a dangerous source of contamination with a harmless one, e.g. an ultrasonic generator, or a the body of a victim by a projected image, etc.

Many of the simulation tools can also be used for planning in a real assignment, for assessing the situations and the effectiveness of different measures taken, e.g by providing what-if-analysis, time-series-estimates, sandbox-like support etc.

SimRad.NBC (Simulation- and Information system to manage Rescue units - with focus on CBRN threats) creates the foundations for satisfying the current user needs for practice oriented simulation and a communication framework for First Responders in CBRN emergency scenarios (Chroust et al., 2008, 2009b).

8 SUMMARY AND OUTLOOK

ICT has brought numerous advantages to humankind but at the same time it has increased the danger of catastrophes due to the international globalization and the often uncontrolled fast execution of processes without control by human sense. We believe that intensive use of ICT can support and improve training. Many of the training tools are also useful in the case of a real assignments. At the same time ICT allows predictive and operational support to avoid and/or mitigate the effects of certain catastrophes.

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