COPE – COMMON OPERATIONAL PICTURE EXPLOITATION

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Use Case Descriptions and a Human Factors Engineering Framework

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COPE

Summary

This document deals with the definition of use cases for COPE. Use cases are design artefacts that represent the future situations of use for which technologies are designed. Use cases include a description of how technologies are used in the future situations.

In COPE use cases are developed stepwise as described in this report. The development process and its steps are outlined in this report. The process proceeds as an interaction between conceptual and empirical work.

- The process begins with conceptual definitions drawn from relevant human factors literature and earlier studies on the emergency response domain. As a result, initial forms of use cases are formulated. We refer to these as Intrinsic Cognitive Demand Scenarios (ICDs).
- Then field studies are accomplished with end users using so-called “lived incidents” to validate ICDSs and to elaborate them by considering possible technologies.
- Finally, the end user input will be crystallised into the actual use case descriptions.

A new format will be invented for the use cases in order to create design artefacts that most effectively communicate future usage situations to technology developers. The target is to better support design under complex and partly unanticipated constraints of design and emerging new needs.

This report also provides the results of the first steps of this development. The structure of the document is such that first the theoretical background of the design approach with which the initial use cases were built with is presented. This refers to chapters 1-4. In chapter 5 the nature of first responder work is characterised by presenting the cognitive challenges that first responders face in every day work and to the tackle of which technological support is expected bring leverage. In chapter 6 the further work of COPE human factors work group is presented.

The results of the further steps of the use case development will be included in the deliverable D3.2 “End user requirements” and D2.2 “HF based design inputs to COPE technology”.

Contents

List of abbreviations

C2	Command and Control
CDM	Critical Decision Method
ConOps	Concept of Operations
COP	Common Operational Picture
CTA	Cognitive Task Analysis
CWA	Cognitive Work Analysis
DP	Decision Point
ER	Emergency Response
FR	First Responder
HMD	Head Mounted Display
IC	Incident Commander
ICD	Intrinsic Cognitive Demands
ICT	Information and Communication Technology
JCS	Joint Cognitive System
JCSP	Joint Cognitive System Patterns
NDM	Naturalistic Decision Making
SA	Situation Awareness
SC	Sector Commander
S&R	Search and Rescue

1 Introduction

The Common Operational Picture Exploitation (COPE) project has set the goal "to achieve a significant improvement in command and control performance, reliability and cost by the integration of COTS solutions and novel technologies to achieve a step change in information flow in both from and to the first responder in order to increase situational awareness across agencies and at all levels of the command chain." (COPE Annex 1).

The Annex 1 also describes the methodical orientation of the project by stating that a usage-driven approach[1] will be taken to develop new technologies for supporting user information requirements at the scene of the event. " as indicated in COPE Annex 1.

The report also draws on the Human Factors White Paper (COPE D2.0). This document was written in order to jointly define the target area of interest in COPE work, and to identify the key concepts that describe the functionalities of the system to be developed in COPE. In general terms COPE focuses on improving the core functions of Emergency Response in which the emerging of a Common Operational Picture (COP) is conceived to be a significant function and element.

The present paper describes the procedure that will be used to define the use cases. It also includes the first version of a use case description. This description will be finalised based on field studies with end users. The use case descriptions are expected to aid the technology development work package in understanding the user needs and technology usage situations in first responder work.

The aim of this document is to:

§ communicate the nature of emergency response work to the technologists on the COPE project
§ communicate the work/performance requirements to the technologists on the COPE project
§ support and guide further field studies and user requirement elicitation
§ describe how usage-driven approach is implemented in the COPE project

2 Usage-driven design approach in COPE

Several important guiding principles were defined for COPE work in the discussions during the kick-off meeting of the project. These discussions are summarised in the Human Factors White Paper produced by the project (COPE D2.0). Successful development of emergency response management activity via implementation of ICT would require answers to at least following questions:

[1] Both notions "user-driven" and "usage-driven" were used in Annex 1. The first notion is more restricted and denotes individual person's perspective whereas the latter refers to the activity of emergency response, including the constraints and possibilities that characterise the domain. The more comprehensive notion "usage-driven" was selected as more relevant to COPE.

- What is the added value that ICT provides into the Emergency Response Management process?
- How does the Emergency Response Management process change once implementing ICT?
- What is the relevance of the new information provided by ICT tools?
- When to provide ICT based information?
- How to assess the value of new information?
- Is there sufficient training for the users?
- Are optional strategies available in case new technology fails?
- Have the possible new types of problems associated with new technology been considered?

2.1 Approaches to studying emergency response

In the Human Factors White Paper (COPE 2.0) an attempt was made to define the scope of COPE, and hence specify what is the particular focus in COPE. The starting point was that the focus is an activity which was labelled *emergency response*. By this we mean the on site, multi-agent activity that comprises of actions that are taken under the threat, immediately before, during or immediately after an emergency impact." (COPE 2.0, p.7). "Emergency response is the operative part of the emergency lifecycle. This is the scope of COPE project from the lifecycle viewpoint. Hence, COPE project focuses on the diverse rescue activities that are launched by a particular event. The whole lifecycle of emergency is taken into account as a context of the actual emergency response." (COPE 2.0, p. 7).

Since emergency response is a complex activity there are also other points of view that are important when studying it (see below). When analysing emergency response from an activity system or also from a process view point we were able to define the scope further and specified that the multi-agency collaboration would involve call centre, fire, ambulance and police (COPE 2.0, Figure 1, p. 8, p.9). While considering the process point of view also the hierarchical structuring of an emergency response activity was mentioned (COPE 2.0, p.9). It was stated that a hierarchical operative organisation with well defined command structure is typical of the activity, and that the grade of implementation of the hierarchy is dependent on the severity and extension of the emergency situation. In the White Paper we did not make a clear proposal to define the focus of COPE in hierarchical terms.

The need to operatively define the breath of the multi-agent and hierarchical emergency response was discussed in the COPE Lisbon meeting in December. The project group agreed that COPE would restrict its focus on the multi-agent emergency response including fire and paramedic services that fire brigades are providing, and the police. Hierarchically the primary focus is on the fire brigade units that operate on the field and the command functions that take place on site either by the unit leader or in some cases also by the P3. A description of the focus will be provided in form of a visual image.

In the COPE project the emergency response activity will be approached from five different view points. These are:

- **A lifecycle view point:** There are four phases that compose the emergency life cycle: mitigation, preparedness, emergency response, and recovery. All of the phases are interlinked but technological leverage potential of the phases can also be studied separately.

- **An activity system view point:** Emergency response is viewed as an activity system which consists of *actors* using *tools* to achieve *an objective*. Fulfilling the objective so that the intrinsic constraints of the work domain are taken into account defines the *core task*. The actors form *a community* which has certain *rules and norms* and which shares the objective by particular *division of labour*. Within the system there are tensions and frictions which will shape the development of the system and each of its constituents.

- **A process view point:** The emergency response of any participating agency includes the following processes: management of response, command control, and coordination. Each of the processes can be looked at separately, but the interrelations and handling of tasks are the interesting parts for the process oriented analysis.

- **A situational viewpoint:** In emergency response, information needs are always situation specific. The value of a piece on information changes with time. Thus, a situational approach in the analysis of the domain is also needed.

- **A developmental viewpoint:** Understanding the history of an activity and the logics of its change facilitate designing its future. Moreover, the content and direction of change is also one of the key contents to be dealt with by the end users who participate in the design of the next generation emergency response activity.

All of the above view points are described more elaborately in “the Human Factors White Paper” (Document 2.0). The situational view point is especially relevant from the point of view of use case descriptions and will thus be elaborated upon here. For example the activity, process and the developmental points of view will be central in defining the new concept of operations later in this project.

2.2 Elaboration of the situational point of view

When defining the information needed in the different phases of the emergency life cycle, process, or by the different agencies involved, it will become evident that information needs are situation-specific. As a matter of fact it turns out to be essential that emergency response processes should be perceived as being structured in particular and idiographic ways each time (Wybo and Latiers 2006).

Wybo and Latiers (2006) draw on the well-known notion of situated action proposed by Lucy Suchman (1987). The first authors claim that the notion of situated action is especially appropriate in the analysis of the structuring of emergency response (ER) processes, and in understanding how actions and cooperation is organised in real situations. ER situations are characterised by heavy accumulation of situational constraints, which makes the situations very complex. Coping with this complexity requires collective distributed decision making. The actual ER activity does not equal with plans and prepared schemes but is, instead structured in the situation according to the local demands. Plans are needed as necessary resources of the construction of the course of actions. Of course also technologies represent “plans” as they crystallize pre-assumptions of the conditions of use, and define ways of tackling the situational constraints.

The advantage to the situational point of view to defining the ER activity and first responder tasks is that attention is drawn to the dynamic features of situational construction of ER activity. Wybo and Latiers (2006) define three dimensions that are relevant in describing the sources of dynamism in the ER situations. The dimensions are: socio-organisational, spatial, and temporal dimensions. They all deal with issues that have to be taken into account when the ER process is viewed as an actual process, and when situational models are created as part of the modelling accomplished in COPE.

Essential to a situational point of view is that descriptions concern particularities of how work is accomplished, technology is working and used, and, that the descriptions are context dependent. These features of the descriptions are not achieved accidentally. Instead, the proponents of situated approaches take the explicit methodological position that the nature of human cognition and action is situated and embodied. The dilemma for design is how to maintain the described methodological position also in design, in which the aim is to create tools and competencies that are generic and appropriate for a variety of situations. It is claimed that it is possible to develop a design approach that is capable of dealing with generic requirements in developing particular solutions at the same time.

3 Intrinsic Cognitive Demands in complex work

In this chapter we shall discuss how human behaviour should be analysed in a design context so that action is considered as situated and embodied but, at the same time, generic features of action are identified and made available for technology development.

3.1 Formative modelling

The need for finding a relationship between the situation specific events and courses of action, on the one hand, and the generic demands that acting appropriately in a certain domain assumes, on the other, was some years ago pointed out by Jens Rasmussen (Rasmussen 1997). Drawing on this idea Kim Vicente proposed the design approach that is labelled formative (Vicente 1999). According to Vicente the concept of formative refers to a type of modelling in design, where the analyst describes “requirements that must be satisfied so that a system *could* behave in a new desired way. (emphasis added)”(Vicente 1999, p.7). Formative is contrasted to normative and descriptive modelling. Formative modelling makes use of Rasmussen’s abstraction-decomposition analysis framework (Rasmussen 1986). The latter provides a helpful tool to understand the intrinsic constraints of the domain that must be taken into account when fulfilling the purposes of work. The framework enables demonstrating the connectedness of lower level phenomena of the system to higher level phenomena, and how the system forms a multilevel means-ends structure, within which each element becomes meaningful. For example, low level data about the temperature in a building from a sensor on a fire fighter (a physical device) could provide information higher up the activity hierarchy that influences decisions about whether the situation is getting better or worse, guiding decisions that have to be made in the higher level contexts of organizational operating procedures and legal constraints. Following a formative modelling approach the product is considered on a new abstraction level. This means that designers make explicit the relationship between the particular solution they are accomplishing and the generic purpose-related functions that this solution is supposed to fulfil. So, for example, if we equip every fire fighter with temperature sensors on their clothes, we would have a possibility to infer how this will impact decision making or problem solving at higher functional levels?

The formative modelling approach is embedded in a frame called Cognitive Work Analysis (CWA) (Vicente 1999).The strength of CWA is in its functionally oriented analysis of the domain and its technological elements. The approach is utilised in COPE in the analysis of Emergency Response domain. The analysis of human action is more traditional in the CWA, i.e. the author does not make an attempt to clarify how human responses to the domain specific intrinsic demands could be described and analysed so that the potential for action rather than particular actualised courses of action are described. In fact, therefore, the idea of formative modelling is not maintained consequently with regard to human behaviour, as Norros has shown (Norros 2004, p. 63-64).

3.2 Cognitive patterns

Some further approaches become helpful in completing Vicente’s approach with respect to the analysis of human behaviour. Our point is that these approaches share the idea of making use of the notion of *pattern* in describing a cognitive system’s behaviour.

We utilise “pattern” in a methodological sense to indicate a generalised and repetitive perspective on a system’s behaviour. A pattern is a mode or way of acting (modus operandi), not a particular realisation of certain course of action. A pattern expresses how, and according to which logic, the demands intrinsic to the system functioning are tackled. Due to connecting actions with purposes, patterns convey meaning. We see that our concept of pattern is very similar to that of Alexander who is well-known for his design pattern concept within software engineering (Alexander et al. 1977).

Depending on the approach, cognitive systems may be comprehended mainly as a human cognitive system (see the section on macrocognition below), or rather as a distributed cognitive system, including elements of technology and of the environment (JCS, CTA below).

The Naturalistic Decision Making (NDM) community (Klein et al. 1993; Zambok and Klein 1997; Montgomery et al. 2005) provides an interesting school of thought that aims at complementing the traditional laboratory-oriented analysis of cognitive processes by a new vocabulary that better reflects human cognition in real work situations. The higher level cognitive phenomena NDM focuses on, have been labelled as “macrocognitive functions” (Schraagen et al. 2008). Schraagen, Klein and Hoffman (2008, p.9) identify six supportive functions and six primary processes. An alternative version of this model is depicted in Figure 1. According to it we identify four functions which are: naturalistic decision making, sensemaking, planning, and coordination. Maintaining common ground, managing uncertainty and risk, problem detection, managing attention are the supportive functions that we consider most relevant (see Figure 1). Beyond these processes and functions Schraagen et al., 2008 also identifies adaptation, developing mental models, mental simulation & story building, and identifying leverage points as important macrocognitive processes and functions. The macrocognitive functions and processes have been abstracted from over twenty years of cognitive field research with people working in many different work domains (see for example, Klein, 1999). They are seen to represent the common, critical cognitive challenges faced by various practitioners. The macrocognitive framework is presented as an initial effort and it is not claimed to be complete. Cognitive field researchers are challenged to add to the functions and processes identified in the Schraagen et al, 2008).

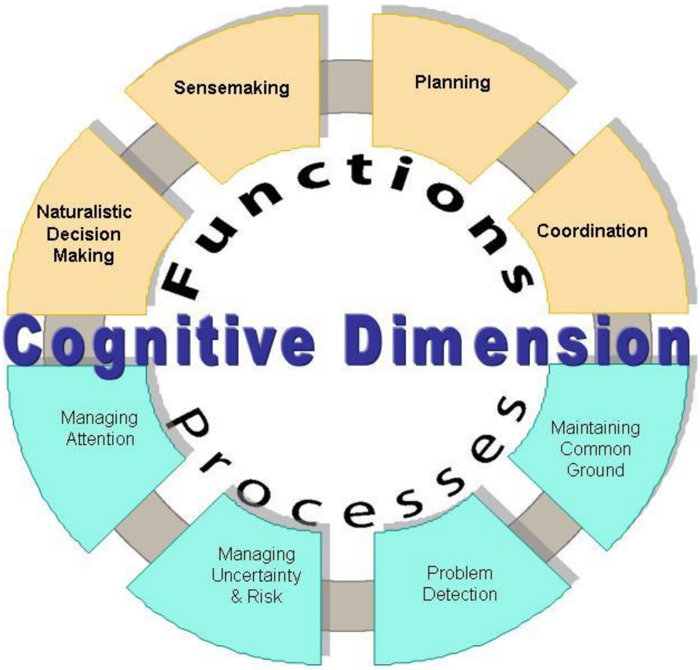

Figure 1. Macrocognitive functions and processes.

The term pattern is not used by NDM community when macrocognitive functions are discussed. The notion of macrocognition is mainly seen to refer to a more global level of analysis of cognitive phenomena as opposed to the microcognitive information processing phenomena. The notion of pattern, however, includes the idea of identifying regularly repeating modes of acting. These portray potential or methods to act in the changing circumstances of the environment. Hence, the epistemic nature of a “pattern” as a mediator between the generic and the particular aspects of behaviour is actually not captured in the concept of “macrocognitive function”. Nevertheless, we interpret the macrocognitive functions to portray patterns of cognitive behaviour in real life situations.

The distributed cognition approach (Hutchins 1995) takes a new perspective to human-technology systems. It advocates the idea that cognition is distributed among human agents, artefacts and the environment, and that from a functional perspective these elements form a unit. This idea could be applied with regard to all technological cultures but it has become especially relevant in the era of information and communication technologies (ICT) of the modern world: Because ICT-based products are not distinct computing devices that people handle but invisible intelligent elements embedded in the environment that function automatically, it becomes more evident and natural to comprehend cognition as something that has a distributed character. (e.g. Dourish 2001).

Drawing on methodological and distributed cognition literature Hollnagel and Woods (Hollnagel and Woods 2005; Woods and Hollnagel 2006) have claimed that cognitive systems form units composed of human and technological elements that work together to fulfil the purposes of the system. The authors introduced the term “Joint Cognitive System” (JCS) to indicate functional units that human actors and technology form. Functions become overt in patterns of system’s behaviour which need to be identified.

Patterns define ways in which the JCS functions; they do not focus on the structure of human-technology interaction. Patterns are “generic demands in forms of work that must be met or carried out by any forms of work” (Woods and Hollnagel 2006, p.11). Woods and Hollnagel identified three main types of patterns: patterns in coordinated activity, patterns in resilience, and patterns of affordance (p. 8). As JCS patterns are defined on functional level, different optional combinations of human and technology may be considered as possible means to deliver the targeted function.

Drawing on partly the same backgrounds than the above mentioned approaches also the *VTT Core Task Analysis approach* (Norros 2004) identifies the need for abstracting from the actual task performance level, and from identifying the sequential cognitive processes, when describing acting in complex work in real situations. Different from the above approaches the Core Task Analysis makes use of the American pragmatist notion of “habit” to indicate the observable behavioural regularities or patterns that are required to fulfil the “core task demands” of particular work (Norros and Salo on-line). By exploiting the notion of habit the core-task approach aims at making explicit that repetitive generic behavioural patterns are not just or mere routines. Instead they are routines that are meaningful responses of practitioners to particular situational cues. The relevance of the response is tested each time of application. Patterns portray a relationship between situational responses and overall purposes of the activity, and they emerge and are repeated because they make sense in the context of use.

Core-Task Analysis emphasises that the core-task demands must be defined domain-specifically. A generic frame is proposed for defining core-task demands. It includes identifying Dynamicity, Complexity and Uncertainty characteristics typical of the domain under analysis, and reasoning what cognitive and emotional resources connected to Skill, Knowledge and Collaborative aspects of behaviour are required to cope with the domain demands. As a result of mapping the domain demands and the generic cognitive and emotional resources a set of Core Task Demands may be acquired. Should we in COPE adopt the Core Task Analysis approach it would be possible to use the notion Core Task Demands to indicate the intrinsic cognitive demands (ICD).

We may conclude that in developing the situational point of view for inferring user needs of emergency response in COPE, we shall make use of the concept of pattern. This concept has been utilised in the three above mentioned theoretical approaches. Each approach contributes important features that will be needed in putting together the COPE approach: NDM contributes a rich description of macrocognitive phenomena, the Core Tasks Analysis approach provides a frame to infer domain specific demands and the behavioural patterns to tackle these, and the JCS approach takes technology explicitly into account in defining cognitive patterns.

4 Use cases in COPE

In this chapter the theoretical considerations of the previous chapter are transformed into a practical step-wise approach with which the use cases of COPE project will be developed.

4.1 What is a use case?

This document is labelled “Use case descriptions and a human factors engineering framework”. This implies that the main content of the document is descriptions of use cases of the intended COPE system. Use cases are definitions of the intended functionality of the system under development (Olivé 2007). Typically, the functionality is described as a sequence of simple steps and a statement of pre-conditions and post-conditions is included.

The situation in COPE project is such that the intended functionality of the new system is not yet clear. The project is in such initial phase that user needs, problems in current systems, and leverage points in the current ways of working have not yet been thoroughly analysed. For this reason traditional use cases cannot be written at this point.

Instead the use cases provided in this document describe the first responder work in terms of general *cognitive demands* that the very challenging high risk work imposes on the first responders and command and control units in the daily work. We propose this approach for the first version of the use case descriptions. Later these initial use case descriptions will be used in field work and even later refined to give more detailed input into user requirement definition and the technology development process.

4.2 Steps in designing and refining the use cases in COPE

The first step in creating the use cases is the definition of the “Intrinsic Cognitive Demands” (ICD) of Emergency Response. In this step analysis is theory-driven. In chapter 3 three theoretical approaches were briefly reviewed that all share the idea that understanding behaviour in a complex and changing environment generic forms of response must be assumed. These approaches have used different notions to capture cognitive phenomena that could be seen to deliver the functions that are needed to cope with the changing environment. We proposed that the term Intrinsic Cognitive Demands (ICD) could be used to indicate these generic cognitive phenomena. The term might be changing when we proceed in our work in defining the ICD’s of emergency response work. The selection of relevant ICD’s is the first step in developing the use cases.

On the basis of the theoretical understanding of ICDs short descriptions of emergency response work are provided. Natural domain-oriented language will be used and the function is portrayed as a situation-specific task with particular constraints, information and communication needs. The ICD scenarios are defined for two activities of the Emergency Response Unit, for the First Responder (FR) and field level commander, the Unit Leader. The scenarios are presented in chapter 5 of this document.

The second step in the process is data elicitation with end users. This step is practice-driven. The aim is to elicit more detailed information of the functions and tasks in the form of *lived incidents*[2]. The intent is to let the fire fighters define what they experience as their work requirements. It is hoped that the lived incidents will sound like he ICDs that we have articulated so far as examples of the requirements that are expected to characterise the work. Then we will generate incident descriptions from real incidents reported by fire fighters. The expectation is that the macrocognition patterns will be well represented within the incident interviews. Some may be more common than others, and we may discover additional cognitive challenges/patterns that are not covered by the macrocognition descriptions. The end users and domain experts are also encouraged to define technologies that they currently use in situations under consideration or optional technologies they would consider helpful in accomplishing the functions and tasks in these situations.

In the third step the field data is analysed and new design artefacts are developed. The first artefacts are *vignettes* which are short and concrete descriptions of situations, in which the intrinsic cognitive demands of the first responder work are portrayed. The vignettes are based on the lived incidents and abstracted so that individual interviewees are no longer identifiable. The vignettes are kernels that represent the user requirements. They are used further in the design process, and may also be developed.

The other design artefacts relevant in this phase are the descriptions of *Joint Cognitive System Patterns* (JCSP). These are descriptions of how the intrinsic cognitive functions can be accomplished by combining human and technological solutions. Optional combinations must be considered. This last phase will be

[2] A lived incident refers to one that the interviewee was personally involved and not “well there was one time my friend went to this big fire and …”. The incident must be from the interviewee’s personal experience.

documented in the further deliverables and scientific outputs of WP2 of the COPE project.

5 Initial Use Cases: Descriptions of Intrinsic Cognitive Demand Scenarios

In this chapter the first versions of use cases, the descriptions of intrinsic cognitive demand scenarios are presented. We have made use of the theory of macro-cognition to define cognitive patterns that each of the short scenarios is supposed to highlight.

Structure of each initial use case is:

- Name: The name of each use case is the name of the Intrinsic Cognitive demand
- Description provides overall explanation of the corresponding cognitive patterns
- First Responder scenario example
- Command and Control scenario example

The scenario examples are a small subset of possible challenges faced by both first responders and incident command and control. They have been adapted from various stories from some fire fighter studies conducted in the late ‘80s in the US (Klein et al. 1986; Calderwood et al. 1987; Klein et al. 1993; Klein 1999). They are intended to provide some grounded illustrations of the types of cognitive challenges that the COPE technology needs to address. They should serve as examples of the types of stories that we want to elicit from our fire fighters and to illustrate to the technologists what these challenges look like from the fire fighter’s perspective and that this is how their technologies might be applied. It is expected that some of these may be revealed to be important, while others turn out to be less important. In addition, in our field studies, we may uncover new cognitive demands not covered by the ones identified below.

5.1 Naturalistic Decision Making

Description

This refers to the challenges associated with deciding what to do, based on an assessment of the situation. In domains where the participants are experienced and the situations are characterised as dynamic, time-pressured, complex, uncertain, with competing goals, decision making can rarely be effectively achieved by classical decision analysis methods. In addition, experienced practitioners are wary of computer-generated solutions (for example by a decision support system (DSS)), unless they can see the rationale, assumptions and information that went into that solution. One model of expert decision making (Klein 1989) proposes that decision making is less about comparing alternatives and more about effective assessment of the situation, putting the onus on support technologies on the presentation of information for the practitioner to make the decision, versus a DSS.

First Responder (FR) Scenario Example

Although fire fighters often claim that they do not make decisions (i.e. compare options according to well defined criteria), they are constantly assessing the situation in front of them, with knowledge of the larger situation, and making choices about what to do. For example, a team climbs on to the roof in order to provide ventilation. The team leader sets foot on the roof and it feels spongy/soft. Is it softer than normal for a burning building? Is it too soft to support the weight of him and his team? Should he continue with his current goal, or should he turn back and look for an alternative?

Command and Control (C2) Scenario Example

In this same incident, the Incident Commander gets a report from his roof team, the roof is too soft and is likely to collapse before the team can ventilate the roof. Will the roof collapsing now help or hinder the fight? Is the roof collapsing expected? Is it indicative of a fire that has been burning longer than expected? Is it time to go from an offensive fire-fighting posture to a defensive posture (save this building vs. let this building go and focus on saving surrounding property)?

5.2 Sensemaking

Description

Sensemaking differs from the standard concept of situation awareness (SA)(Endsley 1995) in that it is the active process of evaluating SA and rebuilding an understanding of the situation once an expectation has been violated. That is, the practitioner suddenly realizes that the situation she thought she was facing is in fact different. The practitioner must assess new information as it comes in with respect to the current understanding; assess whether the new information invalidates the current understanding or whether to reserve judgment for now, or whether to re-evaluate the situation and the current course of action based on the new information. The realization that the situation is not what it seems requires a new assessment and potentially a new course of action. The role of the current understanding (the current frame or mental model or ‘SA’), and the new data that are coming in either through existing sensors or based on active information seeking, are reciprocal in that the data feeds the frame, but the frame also guides what counts as data and what data is sought. This is the process of sensemaking. Sensemaking is active interpreting of particular situations, which allows practitioners learn from experience.

FR Scenario Example

A hose team trains the hose into the second floor of the 4 storey house. They understand that the fire has been contained in the basement and ground floor and they are trying to stop the spread to the upper floors. As they put water on the fire, they expected that as a sign of extinguishing the fire the smoke to change colour from dense white to a steamy, grey (subtle change in colour). After a minute, the colour is not changing. The hose team wonder if maybe the fire isn’t just hotter than they first thought. Two minutes into the event, a report comes in from another team on the other side of the building. There is smoke coming through the third floor window. The hose team wonders where the fire is. Has it spread to the third floor? Has it spread further? Two and a half minutes into the event, a team inside the building reports a previously unknown laundry chute at the back of the house. The hose team realizes that the fire is spreading from the basement, up through the laundry chute, to all the floors in the building, up into the attic. They retrain their hose on the roof to try to bring the fire under control and save the building.

C2 Scenario Example

The incident commander at the same incident (laundry chute incident), receives the report his hose teams and his search and rescue/entry team. He thought it was a simple basement fire initially, but as the reports come in, the information is not in line with his understanding. Why is the fire not responding how I expected? How long should I wait before changing my plan? Is it safe for a team to go inside? Based on a growing concern that the fire might not be what he thought, he sends a team around to the other side of the building to start a hose there and provide a report. They tell him the fire is evident on the third floor of the building. How did it get there? Can I save this building? Or should I give up on it and concentrate on the neighbouring buildings? A report comes in from inside that there is a laundry chute. Now it all makes sense. The fire is climbing the laundry chute and is probably up in the roof already. OK, now I need to give up on this building and save the neighbouring structures.

5.3 Re-planning

Description

Re-planning is typically a result of an assessment that the situation has changed sufficiently from expected (originally planned for) that a new course of action is required. This may be because the decision maker now sees that certain planning assumptions are no longer true, or that the situation is not what the decision maker originally understood it to be, either because the initial assessment was incomplete or wrong, or because the situation has changed significantly, thus impacting the original plan. This is the essence of adaptation to changing events. Re-planning to various degrees is typical in dynamic, complex environments. Typically, there is a realization that the current goal is unachievable by the current course of action. So, either the course of action must be adapted, or new goals must be identified. In some circumstances the goals are rarely well defined. The processes of re-planning are dependent on a shift in SA, an understanding of feasible goals in the current situation, an understanding of the constraints on action (including situational, legal, resources, time, etc.), balancing prioritization of conflicting goals, and an assessment of the amount of friction that will be caused by changing the plan at this point and whether there is time and the communication channels necessary to effect the new plan without causing more trouble than just sticking with the original plan.

FR Scenario Example

The search and rescue team are on the second floor of a four storey apartment complex. They are trying to get to the fourth floor where someone had reported hearing a crying woman. Before they went into the building they had looked at the sketch of a floor plan done by a resident of the apartment complex. They had decided to go up the back stairwell because the front of the building had already been burning for some time. They arrive on the second floor only to find that the stairs to the third floor have collapsed and there is no way through. They realize that they cannot get to the fourth floor from up this stairwell and cannot access it from the front stairwell. They radio the incident commander (IC) that they have to come out in order to come up with a new plan. As they descend, to the ground floor they notice a maintenance elevator that the resident had not mentioned. They tell the IC that they are going to try to get up using the service elevator. He gives them the green light to try it.

C2 Scenario Example

The Incident Commander gets a radio call from his Search and Rescue (S&R) team inside the building. They cannot proceed up the back stairwell; they are coming out to re-evaluate their options. He looks up at the window where the woman's cries were heard. There is a large tree outside the window which is blocking ladder access. He calls on the reserve S&R team to go to the fire engine to see if they put the chain saw in the equipment hold. The S&R team report back that there is a chain saw. The IC is just about to get another engine to put its ladder up to the tree for the S&R team to cut access through the tree when he gets a call from the S&R team inside the building. They have found a service elevator that will get them to the fourth floor and it is working. The IC is not very comfortable with the S&R team using the elevator, but it will take half as long to get up the elevator than hacking through the tree to get a ladder up. He gives his team inside the green light to go up the elevator. He tells his reserve team to get up the ladder and start cutting through the tree just in case, they might still need to get out through the window if the fire makes its way to the elevator shaft. The reserve team begin to cut the tree limbs away when the IC gets another radio call from inside the building. The inside team cannot get into the apartment because the fire doors must be blocked from the inside. They knocked on the door but got no response from anyone inside, but they did think that they heard a cat meowing, but couldn't be sure as their breathing apparatus and all the noise was making it hard to hear.

5.4 Coordination

Description

Coordination refers to the challenges presented by managing multiple actors working towards the same or interdependent goals. These challenges include communicating orders, orchestrating action, maintaining common ground, tracking progress, adjusting the actions based on local knowledge, managing goals in ill-defined situations, communicating leader's intent, and so forth. This is a primary realm of command and control (C2), and less so at the FR level, although the self-coordination of small units may be a critical challenge.

FR Scenario Example

The S&R team are making their way into a large factory through a side door when they are informed that another S&R team are coming in to the same factory but from a different direction. They realize that their efforts would be most effective if they divided up the tasks in some way. The first S&R team had been told to enter the building to find potential casualties in the mezzanine level offices. The second S&R team had been sent in by a different commander to locate a specific hazmat threat. Given that the two teams cannot talk directly to one another, how do the two teams, 1) Realize that they are both in the same building? 2) Understand what each other's goals are? 3) Coordinate their actions so that they are mutually supporting? 4) Divide the work up into the most efficient use of effort?

C2 Scenario Example

The Incident Commander receives notice that two S&R teams from two different units have both entered the same factory with different purposes. He realizes that with two assets in the building, and limited assets elsewhere, he would like to get them in and out as quickly as possible. How does he make the most of this situation? How does he ensure that each S&R team is achieving his intent (i.e. get the job done and get out as quickly as possible), that they are not spending time, energy and air conducting redundant searches, and that they are aware of each other's presence in the building?

5.5 Maintaining Common Ground

Description

Maintaining common ground is a key process for supporting coordination. Common ground is based on:

- common assumptions
- common understanding of the plan, goals and commander's intent
- agreement of tasks and responsibilities within that plan
- updating of new information gleaned from local (un-common) sources
- communicating changes to the plan and rationale for those changes
- managing the tensions between conflicting perspectives on a situation and conflicting tasks and goals

Breakdowns occur due to:

- Different experience bases and mental models of the team members
- Differential access to data
- Lack of rationale for the leader's directives
- Lack of experience together
- Goal conflicts (which are inevitable)

- Failure to appreciate the point of view of other team members
- Failure to proactively maintain common ground

FR Scenario Example

A hose team is shown a map of a nursing home and told to enter the East Wing and search for the seven residents still unaccounted for in that Wing. They memorize the layout as best they can, noticing a main corridor that accesses all the residents' rooms. As they enter the East Wing they enter the main access corridor, they soon realize that the building has been remodelled and the main corridor no longer accesses all the room but is separated in the middle by a heavy fire door. They push through the door into what is now an open communal area, not marked on the building plans provided by the manager of the home. The Sector Commander (SC) had told them to clear the East Wing of residents from their rooms, but now the hose team is not sure where the rest of the residents' rooms are. They communicate back the SC that the other residents' rooms cannot be found, but neglect to let the SC know that the building floor plan has been remodelled. The SC cannot understand how the fire fighters cannot find the other residents' rooms and begins to get frustrated at his inability to get a mental picture of what is going on as his attempts to communicate his plan to the hose team do not seem to be working.

C2 Scenario Example

When the Incident Commander first arrives on the scene, he looks at the fire alarm panel and sees that the fire is detected in "sector 4", the East Wing of a nursing home. He sends his fire fighters in to find and evacuate the unaccounted for residents. He tells them that the fire is in the East Wing, so be careful as they conduct their search and to let him know exactly where the fire is located. He later hands responsibility of the sector over to a Sector Commander as the incident escalates. The SC is told about the IC's assessment and the course of action that is currently being executed. He hears back from his fire fighters who are having trouble locating the fire and the residents' rooms. He cannot understand why they are unable to continue their search effectively, and more worryingly he does not yet know where the fire is exactly. Unbeknownst to him, the fire fighters have discovered that the building plans had not been updated following a remodelling and that the interior of the building looks very different from the plans that the IC has. Not only that, if he had known that the building had been remodelled, he might also have realized that the alarm system sectors had been rewired. Areas of the old Sector 4, are now actually under Sector 5, and there are now additional rooms under Sector 4 that are not marked on the outdated map. He has actually sent his fire fighters into a much less dangerous area than he had first thought, and that the real emergency and priority was in the new Sector 4 where the fire has been burning undetected by his crews and un-hampered by his efforts.

5.6 Managing Uncertainty & Risk

Description

This is a key challenge in many complex, dynamic environments. All the required information is often either not available, not clear, conflicting, and/or has multiple interpretations. This means that decision makers must act in spite of the uncertainty and, given the stakes, take risks in the face of uncertainty. Experts develop strategies for managing uncertainty and taking "calculated" risks (meaning that they understand the risk and often do not expose themselves to catastrophic failure, but generate courses of action that may fail, but from which they can recover). Uncertainty has been defined as "doubt that blocks action." (Lipshitz and Strauss 1997). The doubt can arise from a myriad of sources, yet often not making a decision is the worse option. So deciding and acting under uncertainty are a way of life for operators in environments like fire fighting, and risk is increased due to the potential for loss of lives and property.

FR Scenario Example

The Search and Rescue team enter the building to search the first floor. They do not yet know where the source of the fire is, or what kind of fire it is. The building is an apartment complex and it is 9pm on a Saturday. They are unsure of how many of the residents of the flats are actually at home at this time. They do have some information from other residents who had already evacuated the flat that there are at least two families of four on the ground floor, with young children who are likely to be in bed at this time. The children's bedrooms are the first priority for the S&R effort. The team enter the flat number provided by one of the residents and pass through a living room into the back of the flat looking for children's bedrooms. The smoke obscured the team's vision. They entered what appeared to be a young child's room, the bedding was messy, but so was the rest of the room. Had the child been asleep here tonight? There was no child to be seen. They checked the cupboard, and under the bed. No sign of the child. They moved to the next room, an older child (based on posters on the wall and other critical cues). The bed was still made, not slept in. No one was in the room. Where are the children? Maybe they are in the parent's room? Maybe they are all out for the night? Or away for the weekend? They move through into the parent's room. The bed was made. No sign of the parents or the children. What to do? Could they be somewhere else in the building? Or are they out for the night and no longer a concern? Where could they got confirmation of the whereabouts of the family? Would the neighbours outside have anymore information or ideas? Could they have seen any clues that the family may in fact be away for the weekend? As they leave the flat, they mark the door with a big "X", "cleared," and move on to the next flat. There is already an "X" on the door. Move on to the next one.

C2 Scenario Example

The Incident Commander hears back from his S&R team. No kids in Flat 3. Is there any other information about the family? Are they even at home this weekend? The Incident Commander asks one of his men to question the neighbours again. Could the family be away? Could they be in another flat in the building? Do they tend to spend a lot of time away at the weekends? Meanwhile, the IC checks the building maps and the resident lists. How many of we got out already? How many might be left? How much time do the guys inside have to continue before we need to swap them out? Have we located the fire yet? How far has it spread? How quickly is it moving? Do we have time to search the rest of the building? Where are the most likely places for the remaining residents? Are there any communal spaces? We're not even sure how many people are in residence this weekend… is it time to give up on the S&R and the building yet? What can I do to prepare for different eventualities? Can I begin to position engines to be ready to stop the spread of the fire any further if we decide to give up on this block of flats?

5.7 Problem Detection

Description

Detecting problems is a critical challenge in many domains. Many theories in psychology deal with problem solving, but few describe or explain how people detect problems in complex work environments. Two critical skills include anticipating potential problems based on a mental simulation or projection of the current trajectory of a situation or event and predicting where it will go in the future. The second is the detection of a problem as the situation gradually shifts from the expected path and into territory that is unexpected and unwanted. This is even more difficult to do when the approved or acceptable trajectory of a situation or event is not well defined. For example, in a nuclear power plant or process control, there are clear parameters with regard to what represents an abnormal or unacceptable state. However, in an emergency situation, the situation is by definition abnormal, but what constitutes a problem with regard to managing that situation. Several factors impact the ability of personnel to detect problems. They relate to the problem itself, the operator/decision maker, and the types of actions that can be taken. With respect to the actor, issues relating to experience levels, actor's "stance", what are they paying attention to, other operators in the situation, and individual differences impact problem detection ability. With respect to the situation itself, how the data is sensed (resolution, update rate, types of data, etc.), how it is presented (uncertainty, speed of changes in values, non-linear progressions, etc), and what kind of problem it is (routine situation deteriorating; recovering situation deteriorating; multiple faults; reduced margin of safety; weakness in a plan; weakness in an action; and transient faults) all impact the ability of the operator to detect the problem.

FR Scenario Example

A hose team is training its hose on the second floor of a four storey building. They believe that the fire is contained in the basement and ground floor of the building and have been told to douse the fire and cool the upper floors. The fire does not seem to be going out. It's putting up a stronger fight than they first expected. They keep the hose aimed in the same place. The smoke doesn't seem to be changing colour as expected either. This is a really tough fire. Then one of the team notices smoking coming out from under the eaves of the house. Where is that smoke coming from? Has the fire spread? Or is the smoke coming up through a stairwell or another access? Could the fire be making its way up there also? Why is this not working? What is going on? Do we have to re-evaluate and maybe send a team in to the building or round to the back to identify what the fire is doing and why it is not behaving as expected?

C2 Scenario Example

The hose team radioed to the IC that the fire appeared to be holding out much harder than expected and that they suspected that the fire may be getting up into the higher floors somehow. The IC had sent a team around the back of the building and that team confirmed that the fire had somehow reached the upper floors and was now attacking the rafters. The IC instructed an arriving engine to train its hoses onto the roof once it was set up. That should do the trick, thought the IC. He turned his attention to the problem of the growing media crowd on the other side of the park. When he returned five minutes later, the fire on the roof was still licking under the eaves of the roof and getting worse. Where was the other engine that he had told to douse the roof? He couldn't see where they were supposed to be. Where were they? He called on the radio, "Engine 5, where the heck are you?"

"We're having trouble getting through the alley way, there's a car parked next to the hydrant, and we can't get our hoses to reach around far enough. We sent a runner to let you know, because we couldn't get hold of you on the radio!"

"Well, get it under control, I need water on that roof now, or it'll be too late!" "

The IC looked back at the building. The water from the other hoses did not seem to be having any impact. Was it time to give up on this building and just protect the neighbouring buildings? Or was it still controllable? Why was this fire so hard to put out? And how did it reach the roof so quickly? Was he missing something? Was this not what it seemed?

5.8 Attention Management

Description

Fire fighters are bombarded with sights, sounds, tastes, smells, and physical contact with others and the world around them. What is important? The challenge facing the decision maker here is that there is often so much information coming in and so much going on, that knowing where and when to focus attention is a real challenge. Experienced personnel know where the most diagnostic information is, how to get it and when it will be useful. They know how and when to focus on what is important in a given situation, even when others are clamouring for their attention.

FR Scenario Example

The S&R team were getting towards the end of their time in the building. One of them was running low on air. They were both sweating hard as they made their way up another flight of stairs. The noise of their heavy breathing filled their ears. They couldn't really see very much with all the smoke. Which way now? Were they heading back towards the exit or away from the exit? Where was the manager's office supposed to be? There was a crackle in their ears from the communications system, was the IC trying to tell them something? It certainly seemed to be getting hotter the further down the corridor they went. The floor felt insubstantial below their feet. How much longer did they need to stay in there? Wasn't it time to go out? Where was the manager's office? Someone had said that the manager had not got out of the building yet, and that his office was in the middle of the building on the fourth floor. Surely they were at it by now? What was that noise? Was that a voice? Or a cry? Or just a trick of the sound? Wait, my breathing is laboured, what's going on with my breathing apparatus? What, no air? Damn it, how did I get through that so quickly? Hey, John, I need to get out, now!

C2 Scenario Example

The IC is busy responding to multiple request from various parties: his fire fighters on the ground, the media, the police officer in charge (OIC), the ambulance OIC, the owners of the surrounding buildings, his 2 I/C, his communications specialist, his BA specialist, his hazmat team leader, the bomb squad OIC… they all demand his attention. It is easy to become distracted by the various parties who need information, or who have information for the IC, who are reporting back from tasks they have been issued, who need new tasking, etc. etc. Remembering what tasks have been ordered, which are pending, which are in progress, which are complete, what resources have become available, how the fire is progressing, whether the fire is progressing as expected, what potential problems might have to be dealt with, and so forth all demand attention from the IC at various points in time. Some are triggered by events, some by time, some by suspicion/doubt about how things are progressing.

5.9 Common Operational Picture (COP)

As indicated in Chapter 4, Joint Cognitive System patterns of emergency response are going to be identified in the final phases of the use case development. JCS patterns describe how the cognitive functions and processes (coined as Intrinsic Cognitive Demands) that have been identified as relevant for fulfilling the aims and purposes of the activity may be realised by combined human and technological efforts. As has been indicated the Intrinsic Cognitive Demands that could be identified via theoretical analysis and existing research results are elaborated in field studies via "lived incidents" of end-users in the three countries, UK, Ireland and Finland.

The JCSs patterns support various needs of the first responders and C2 personnel. The Common Operational Picture is an integrated result of the functioning of many of these patterns. COP is a means to fulfil the functions that have found to be relevant in first responder work. The challenges for human factors in the next phase of COPE is to

- define what Common Operational Picture is
- participate in defining in concrete and technical terms examples of joint cognitive systems for ER
- define conceptually how joint cognitive systems promote COP
- demonstrate how JCS functions to provide COP.

In the Annex 1 of COPE, Common Operational Picture was considered to be the central concrete target of the COPE project. What is meant by COP has remained rather open, which is natural, since defining it is the central generic research issue of COPE.

The way the concept is used in Annex 1 is in line with the above idea of COP. In Annex 1 it was indicated that COP deals with information that is needed to create and maintain a “picture” of the emergency situation. The “picture” must be shared so that multiple agents can act in a coordinated way horizontally and vertically, but different agents also need “pictures” that correspond to their particular responsibilities.

The concept of COP was dealt with in the Human Factors White Paper that was launched in September. The White Paper definition of COP was presented also the Bucharest meeting. Thereafter a discussion was going on in e-mail within COPE participants. The present understanding of the concept of COP within the COPE project is summarised below.

In the white paper presentation in Bucharest we proposed to consider how COP is created in order to understand what it is. We wrote that

- COP is an outcome of a joint functioning of human actors and technology
- COP is related to awareness of

- Situation-specific operational goals and resources and their relationship to overall purposes of ER
- Actor's own activity and effect on the system
- Other actors' activities and effect on the system
- The environment
- Constraints/limitations on action (e.g. rules, laws, limited resources).

Drawing on the above understanding of how COP is formed, and on the inputs in our joint e-mail discussions and those in the Lissabon meeting the following definition of COP emerges:

Common Operational Picture (COP) is the description in time of the emergency situation that supports the emergency responders within and between different agencies to act appropriately.

COP is described as the pool of information

- that is registered and stored in a database
- concerning past, present and expected future events
- that is available for presentation in a user interface suitable for emergency responder work
- form of presentation of which is consistent and unambiguous, but not necessarily similar to all stakeholders
- content of which is structured around operational processes of the emergency responders
- that needs to be interpreted and acted upon by the emergency responders
- that is meaningful in the context of emergency responder work

6 Exploitation of use cases

This document describes the first initial version i.e. precursors of the use cases as intrinsic cognitive demands and related scenarios (previous chapter). The use cases here have been produced by analysing first responder work with experts and referring to theoretical assumptions about complex work. In the next phases of the project the use cases have twofold exploitation needs: To be used in structuring field work for WP2 and to be used in design work of WP5.

Further, technology mapping activities will be accomplished to bridge between the definition of first responder Intrinsic Cognitive Demands and the design of technologies. Figure 2 illustrates the exploitation of the two main branches of the technology development process of COPE and how use cases are serving the concept and technology development process. The arrows and arrow cycle indicate the efforts that have been labelled as technology mapping.

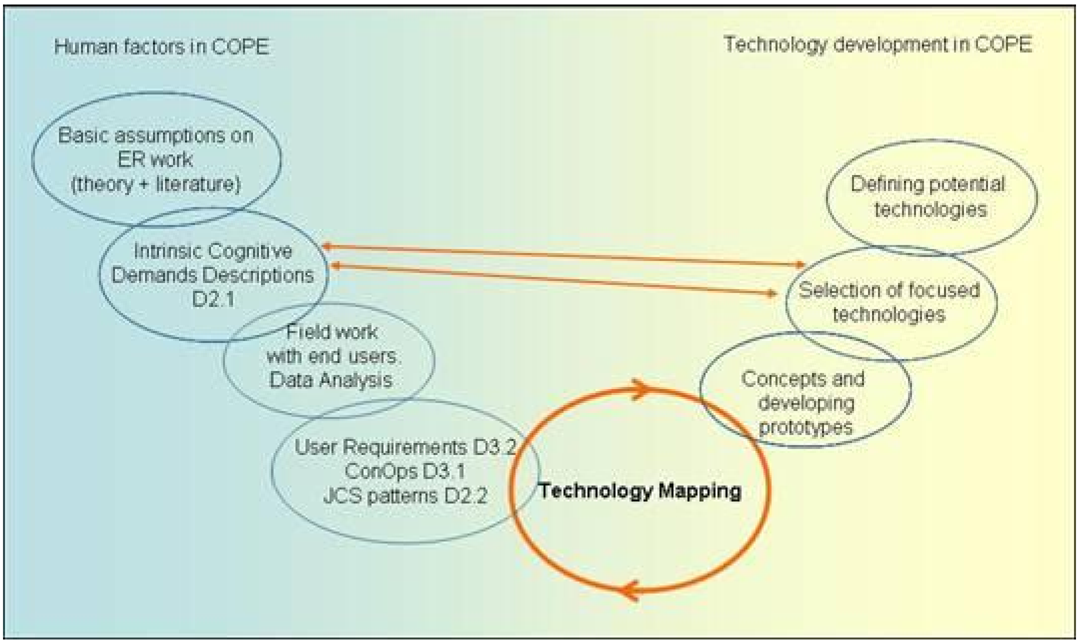

Figure 2. Exploitation of use cases and technology mapping

6.1 First responder field studies

The next phase of the human factors work packages (WP2 and WP3) in COPE project is field work. The described use cases will be exploited in user interviews and observations.

Goals of the field studies at this point are:

- To identify the first responder cognitive and functional work requirements and work challenges
- To identify lived incidents that are related to intrinsic cognitive demands presented by the initial use cases
- To identify potential leverage points for technologies
- To identify potential new CONOPS for envisioned technologies
- To identify possible measures of performance for the evaluation of human-machine systems.

Not all these goals will be achievable within one interview or from a single incident account. Some of these goals will be addressed indirectly from analysis of the incident accounts; others can be explored directly in the interviews.

Approach

We will base our interview method on the Critical Decision Method (Klein, Calderwood, & Macgregor, 1989) to elicit lived experiences from fire fighters, and to ground discussion in real events (versus hypothetical scenarios that will often elicit only opinion and generalizations). The interview method will be adapted according to available resources and available interviewees.

The interviewer will attempt to elicit lived-incidents[1] from the interviewees. As background and motivation presented at the interview, the selected three emergency response case studies will be used (Enschede fireworks factory; chemical spill on the highway and large road traffic accident). [a 'lived-incident' means one that the interviewee was personally involved in and not "well there was this one time my friend went to this big fire and…" The incident must be from the interviewee's personal experience.]

Also the above defined intrinsic cognitive demands are used as background material for the interviews.

The CDM will be adapted with a final sweep through the incident where the interviewer will present the interviewee with the opportunity to envision the use of various technologies in the context of the previously experienced event (or in future interviews, explore the role of the evolving CONOPs in the context of a past incident).

The initial interview guide is presented in the appendix A of this document.

6.2 Exploitation of use cases in technology development process

The initial use cases described in chapter 5 should also be used as input in the technology design work package of COPE project.

First of all the descriptions of the intrinsic cognitive demands will help everybody understand the nature of the work for which technology is being developed . The related small example scenarios will give even more realistic notion of the nature of the work.

The goal of the COPE project is to increase situational awareness through providing the common operational picture (COP). In order for the new technological solutions to actually provide a meaningful and useful and thus acceptable COP to the first responders and command and control personnel the nature of the cognitive processes related to the work must be thoroughly understood.

At this point, while reading the ICD descriptions and related scenarios, each technology developer might want to start to analyse and envision how his/her own technology might support the described cognitive process and how the technology could help in the activity described in the scenarios. This kind of thinking and envisioning will help in deciding on the final implemented functionalities of COPE technology.

7 Conclusions

This paper presented first results concerning development of use cases. These are meant to be exploited in the design of technologies for emergency response work. The report includes theoretical accounts that were considered necessary to provide reasons for the conceptual choices made. The major conceptual issue was how to define use cases in usage-driven design process. The method is described in the report.

The report also includes results of the first phase of the use case development. This phase concerns the definition of the cognitive functions, or, as they were labelled her “Intrinsic Cognitive Demands” (ICD, that should be fulfilled to carry out a successful emergency response activity. The ICDs are descriptive and rich way as small scale scenarios that give realistic understanding of how the work of first responders and command and control actors look like. Previous experience and research results were exploited in the formulation of the ICD scenarios.

The report is delivered with the aim that it will be used in further work of the project. The use cases are in this report in an initial form and they will be elaborated in the forthcoming work of the project.

Appendix A – Interview guide

(This method is based on the Critical Decision Method described in “Working Minds” by Crandall, Klein & Hoffman (2006).

The interview methodology is described in terms of ‘sweeps’ or multiple accounts/iterations of the same incident, focusing on different levels and types of information each time.

Selecting the interviewee & Building Rapport

We need to make sure we are talking to the right people. If we are interested in the Command & Control (C2) piece, then we need to talk to people with recent experience of incident command, tactical C2 operations, etc. If we want to understand first responder (hose teams, search and rescue, etc) then we need to talk to people with recent experiences in that role.

Make sure you explain to the interviewee at the beginning of the interview that we are trying to understand their working environment, the challenges they face, and so forth. We are NOT there to evaluate them or judge their actions. We ARE there to understand how they bring their experience and expertise to bear on overcoming challenging situations. Descriptions of their mistakes is OK as well if they are willing to share them, but we are equally if not more interested in their successes.

At the beginning of the interview I would warn against raising the issue of technology or the real purpose of the study, otherwise they may try to anticipate your questions and make suggestions that are based on their opinion and may influence their responses to the initial questions. We are interested in their ideas and opinions, but we want them grounded in their lived experiences, which we will elicit in the interview first. When we have our detailed incident account, then we can ask them how advanced technologies might have helped, but not before.

We should probably explain the purpose of our research to them at the beginning (not sure if there is any requirement for a consent form here?). But we should keep the technology-focus out of the initial description, in my opinion. For example:

Project Background: We are working on a project for the European Commission to understand the challenges faced by first responders in emergency response situations. We are especially interested in what makes you good at your job, especially with respect to assessing situations and making tough decisions, adapting to challenging, changing situations, and coordinating with other team members. In order to do that, we’d like to ask you to tell us about some of your own personal experiences. We will be asking you some specific questions about those experiences, so we want to hear your stories but we also want to structure the next one to two hours. You will have to excuse us if we cut you off in mid-story with questions. OK?

First Sweep: Initial Account

Interviewer: Can you tell me about a time when your skill as a fire fighter was put to the test. We are especially interested in experiences that are in one of the following three categories:

1) large plant or warehouse that has explosive or hazardous materials (specifically a fireworks warehouse if possible)

2) chemical spill from a traffic accident specifically hydrochloric acid if possible.

3) large scale road traffic accident with smoke from land fire implicated in its cause

If you do not have experiences of this type, then any experience with a multi-unit response, with multiple agencies at the scene, possibly multinational, and larger scale implications will do.

[Note: are there other criteria we can apply for experiences relevant to our project?] see insertions above

Interviewer: If you have more than one, tell us about several. Please briefly (in no more than five minutes) describe the events. We will revisit different aspects of this event in detail later in the interview, for now we just want a brief overview description.

Tip: if the interviewee has several examples, listen to brief descriptions of each and decide which are most relevant, challenging, interesting for our purposes. Aspects of situations where the interviewee's skills were challenged are often the most fruitful

Second Sweep: Identify Events and Decision Points (DP) on a Timeline

The goal of identifying critical events and decision is the "leverage points" which will be used in defining the new concepts of operations of emergency response (McDonald 2008, WP3).

Interviewer: OK, now that we have had a brief description, I want you to describe the incident, identifying a concrete beginning and end to the incident. Between the beginning and the end, I want you to identify, on a timeline (doesn't have to be absolutely accurate), all the critical events and especially decisions that you had to make.

Tip: as the interviewer you are trying to bound the event with a beginning and an end and identify the sequence of events so that you can go back and deepen on each critical (and presumably challenging) aspect of the situation. Timing does not have to be accurate, but order of events/decisions is important

Definition of a critical event or decision point (DP) is:

§ any significant external event

§ assessment point

- choice/decision point
- planning point
- reassessment/shift in assessment
- re-planning/adaptation to new circumstances/assessment
- coordination point across multiple entities/actors

Tip: If you have access to a whiteboard it is often helpful to draw the timeline on the board and identify the points on the white board for all to see. It often acts as an external memory jogger for the interviewee. Also, if you see large gaps in the timeline where nothing is happening, you should ask the interviewee if there was anything that they have missed or important during that time. If they can't remember everything, this is also fine, They may remember later, or it may be unimportant, but either way there will be enough data from the other DPs to satisfy our data collection goals. If the whole incident seems very thin, or memory is poor, or the incident seems irrelevant, go back and ask for a new incident or review one of the other incidents described at the beginning.

Third Sweep: Deepen on Each DP

The goal of deepening each DP is to identify corresponding Intrinsic Cognitive Demand.

Interviewer: For each DP, I am going to ask you a series of questions. We'll try to work through all of them one by one.

Tip: if there are a lot of DPs, it is often worth asking the interviewee which were the most critical or challenging, trying to provide some order on how you address each DP. You might not have time to deepen on them all.

For Each DP Ask:

- What was your assessment of the situation at this point in time?
- What were you trying to achieve?
- What information or aspects of the environment were you paying attention to?
- What did that (the cues/information) tell you about the situation?
- Was anything surprising or unexpected at that point in time?
- What other factors impacted your assessment?
- What did you do in that situation?
- How did you think the situation would evolve at that point in time? What did you expect to happen?

- § How did you decide what to do? Were there several options that you considered? If yes, how did you choose? If no, what was it about the situation that led to the decision to do that?
- § What made this aspect of the incident particularly challenging? Why was it difficult? If you had been less experienced, what aspects of this situation would have caught you out or given you trouble?
- § What kinds of mistakes might a less experienced fire fighter have made in this situation?

Systematically ask these questions for each DP, trying to get to them all, or at least the most challenging. Remember that each question refers to the interviewee's understanding and actions AT THAT POINT IN TIME. Make sure you focus the interviewee on that particular point in the incident.

At the end of this sweep through the incident, you should have a detailed account of the incident from the interviewee's perspective, and have a complete understanding of the challenges and issues faced by the fire fighter and how they overcame them.

Fourth Sweep: Technology Implications?

The Purpose of the fourth sweep is to explore some alternative scenarios and try to get even more out of the interview. You could ask hypothetical questions to explore alternative assessments or choices (and why the interviewee decided to ignore or discount those)

E.g. For each DP ask:

If you could have any technology or piece of information at this point in time, what would you have wanted? How would it have helped? How could you envision using it?

Goal: ask the interviewee to identify potential technology supports/solutions first)

2) What would have happened if you had had X (e.g. HMD) at that point in time? How would it have helped? How could you envision using it?

Goal: ask the interviewee to consider some of the technologies that have been suggested for COPE

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