Learning Role-Playing Game Scenario Design for Crisis Management Training: From Pedagogical Targets to Action Incentives

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Abstract. Emergency and crisis management requires, from operatives and decision-makers, specific knowledge that cannot be acquired through theoretical course or real-life practice only [1]. Besides, developing practical exercises adapted for agents and their needs is even more difficult when the system where they operate is complex [2]. It is therefore necessary to develop such exercises according to both rigorous and flexible methodology.

Since 2015, the Expert'Crise project, funded by the European Social Fund, has organized seven exercises mainly in hazardous chemical companies. During such exercises, trainees play their own role in their usual working place. Hence, arrangements must be made [3] to isolate trainees from real environment and establish exercise diegesis [4]. Through a trial and error experience, we developed a design methodology for crisis management Learning Role-Playing Game [5] scenario.

Scenario design starts from trainees' statement of requirements leading to pedagogical targets, chosen from an existing classification [6]. Then, because emergency sequences are often similar, we developed a framework for our scenario based on the narrative storyline of J. Campbell [7], describing the steps of an emergency sequence. Nevertheless, because pedagogical targets change depending on exercise, this storyline varies and includes dedicated "situation-tasks" that target competences previously identified. These situation-tasks aim to "force" trainees to do actions under special circumstances through serious game interface [8], and using its gameplay and diegesis. However, "situations" may not lead obviously to a "task", and incentives must be introduced to help trainees performing the task, unlike disturbances [9] that can also be added.

Keywords: Education and Training, Safety and Health, Crisis management, Seveso.

1 Introduction

1.1 Background

Despite the progress of major accident prevention since the 1970's and accident such as those of Flixborough or Seveso, there are still industrial disasters. Proof, if needed, that prevention alone is not enough and safety needs emergency management when a disaster occurs. Yet emergency and crisis management requires specific competences that cannot be acquired through theoretical course or real-life practice only [10]. They must therefore be trained through practical exercises adapted to their environment, working habits, education, and professional needs. Moreover, European regulation known as "SEVESO 3 Directive" requires hazardous companies to test their emergency planning every three years, for instance with exercises.

Nevertheless, developing such exercise is a complex task that requires dedicated skills [11]. This kind of training already exists but is mainly oriented to public organization [12] or outsourced to consulting firms. Therefore, because organizing exercise in industrial plant is complicated, expensive, and comes with uncertain outcomes, companies may be reluctant to organize such exercises [13]. To test the emergency management with exercises, SHE managers need a methodology to easily set up internal exercises matching with their goals.

Launched in 2015 and funded by the European Social Fund, the Expert'Crise project develops emergency and crisis management training for hazardous industries and critical infrastructures. These training are based on a pedagogy combining theoretical courses and immersive practical exercises. Through a trial and error experience, and the literature from different fields such as pedagogy, dramaturgy, game design, and crisis management, a design methodology for crisis and emergency management Learning Role-Playing Game [5] scenario was developed.

1.2 Context of the Development of the Design Methodology

Eight walloon SEVESO companies have participated to one of the six exercises organized between 2015 and 2017. Eight other exercises are currently under preparation for 2018. Companies, their environment and the type of exercises [8] proposed vary from an exercise to another and cover a wide scope of situation.

Exercises were held on industrial sites and used rooms, tools and communication devices available to operatives and decision-makers both in their work-life and during emergency. This configuration allows immersive situation for trainees without destabilizing them [14]. In addition, it provides an emergency system test for companies in accordance to European regulations [15]. Exercises are mainly functional [8], focused on decision-maker functions [16]. The operational part is often simulated through the control of information flow entering the crisis room. Therefore, these trainings target members of the crisis management team and key persons in the warning chain.

Exercises rely on material arrangement and human organization. Human organization refers to facilitators regulating the exercise [9] near trainees (or at distance) and observers consigning what happened during the event. Experimental device is composed of cameras, microphones, projectors and speaker that allow immersing trainee in

the diegesis and, on another hand, capturing multimedia flows that are lived-streamed to distant facilitators to help them adjusting the scenario and saved to complete observers' notes for later analysis.

The framework of the training offered remained the same throughout the project: one to six theoretical course modules, briefing of some or all the trainees, simulation, "hot" debriefing right after the simulation, analyse of the simulation [17]. and "cold" debriefing. Nevertheless, inside this framework, each step have evolved to take previous mistakes, bias, limits and suggestions of improvement into account.

2 Methodology: from Pedagogical Target to Action Incentive

Like games, Learning Role-Playing Games need rules, medium, context and players [18]. Rules and medium are defined by the category of game but context and players vary depending on the company. Therefore, before considering developing a scenario for the exercise, these two elements must be properly defined with the company and will allow to build the proper diegesis – i.e. what is true in the context of the simulation – for the exercise. Then the methodology is split in two main parts. The first one analyzes needs and wishes, and emergency system of the company to propose a pedagogical and organizational framework for the exercise. The second part designs exercise content inside the previously defined framework.

These two parts are not isolated from each other, and the development may step from one to the other depending on the progress of the pedagogical engineering and the reactivity of industrial contact person. In addition, the methodology is iterative so some steps are looped several times.

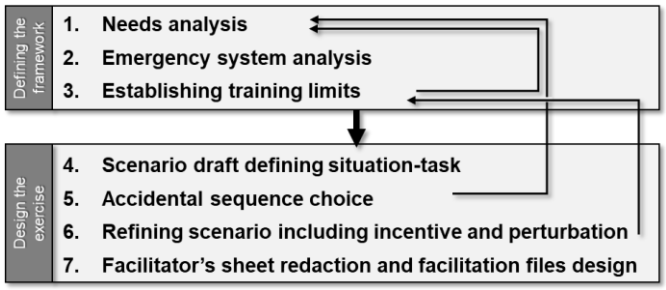

Fig. 1. Structure of the emergency exercise design methodology

2.1 The Framework: Defining Needs to Specify the Scope of LRPG

After the company agreed to participate to the training, a meeting is scheduled to deal with needs and expectations of the firm. This **first** meeting aims to have a first scope of the training company expectations including target audience identification, resources that can be used and operational (e.g. evacuation or intervention exercise, warning

chain test…) and/or global (e.g. improving reactivity, internal or external communication…) objectives. These objectives formulated by the company must be interpreted to fit emergency and crisis exercises pedagogical targets identified in literature [6].

The **second** step is about processing emergency plan and organization documents into a mental picture of how the emergency system works. It appears emergency plans from European Seveso companies are similar [3] with separated operational on site management and strategic management in a crisis room. This common structure is convenient and allows building mental picture from an existing framework. A second meeting with the contact person is then usually needed to clarify or verify some points. This meeting may be held with other persons of the companies to have a better description of their role and seize the difference between the prescriptive plan and what they would do during an emergency according to their experience, their working procedures and habits. Therefore, it is possible to have a representative picture of how the emergency system could be expected to work during an emergency.

Once the company's needs and its emergency system is understood, the **third** step is about establishing borders of the sub-system tested during the exercise and figuring out how this sub-system will evolve during the simulation and especially how it will interact with the defined borders. This step lead to define, considering the target audience, a second category of audience: the peripheral audience. Those persons are not directly aimed by the training but they play an important role in emergency plan and are direct interlocutor to target audience so they have to participate, if possible. Nevertheless, because they are not directly targeted, facilitators mentor them by telling them how to interact with the target audience. Therefore, they can be seen as an input/output interface for facilitation. In the same way, indirect interlocutor such as medias, political stakeholders, administrative authorities and emergency services are identified according to company's needs and facilitators simulate them during the exercise through phone, mail or other means [9]. To this end, a sheet showing exercise's phone numbers and corresponding stakeholders is displayed in rooms where target audience is expected to be. Explanations related to this sheet as well as other immersive device and interfaces are given to trainees before the simulation or, if it is not possible, during the exercise by facilitators.

Once all trainees are identified, areas where they are supposed to be can be considered. The crisis room, the disaster area, the guard post and the control room are usually the main relevant areas for chemical industries exercises. Nevertheless, according to activities of the company and its wishes, areas may be added or removed. In this last situation, a specific interface is set up according to the target of the exercises defined previously. It can be a reduced model simulating on-the-ground operations, leaded interviews with intervention leader or sub-crisis unit managed by a facilitator. These simulations aims to give to the target audience an immersive experience including the correct information flow and realistic interactions with stakeholders as represented in figure 2.

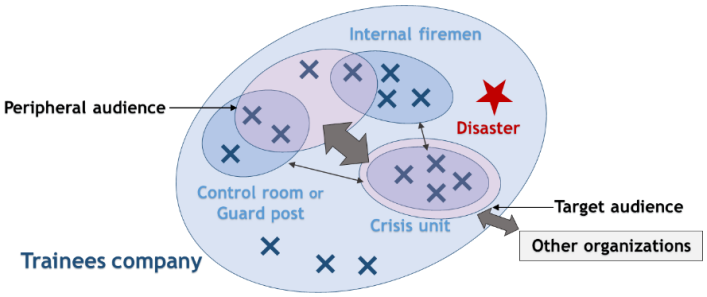

Fig. 2. System borders audiences and others organizations simulation

An analogy can be made with theatrical scenography. Indeed, this step consist in building a scenery where trainees will evolve as actors and, the same way scenography use cardboard environment to improve immersion, it may be relevant to use trick such as smoke-producing device, alert horn or other sound and light device to simulate events and strengthen realistic feeling of trainees, actors but also spectators of the simulation. Nevertheless, these tricks do not have to be fully realistic with a homogenous diegesis and can only be representative or symbolic with a heterogeneous diegesis [4], the same way an accessory – such a hat or glasses – is enough to understand a same actor plays different character.

The last border, which should be defined, is the duration of the exercise. They usually last between one and three hours for logistic reasons but longer exercise could be planned.

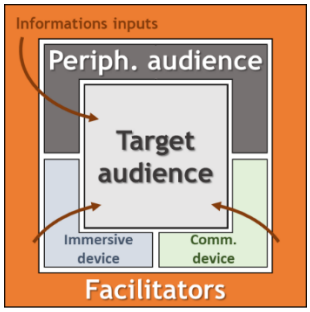

Fig. 3. Audience, simulation device and information flow

Therefore, once interfaces between trainees, environment and facilitators are defined, context and players are set and the LRPG is operable. Therefore, an exercise draft can be submitted and the scenario development initiated.

2.2 The Scenario : Designing an Interactive Story to Achieve Pedagogical Target

Once the framework is defined, scenario can be developed, it is the **fourth** step. A scenario explains the diegesis of the exercise and develops the sequence of input to the target audience, which should lead it to pedagogical targets [19]. Based on targets expressed by the company, knowledge and competences [20] are selected from an existing list [6]. At this point, situations staging competences are considered. The relevance and the ease to stage of each situations are then evaluated to choose the more adapted situation for the exercise. This first association between knowledge and situation are proto-"situation-task" [21]. A situation-task are the central part of these exercises and aims to "force" trainees to do an action (the task) under special circumstances (the situation) through serious game interface and using its specific gameplay. The task is a mean to involve trainees in a reasoning process harnessing knowledge targeted [22]. Once all knowledge, skill, and competences that will be aimed by the exercise are identified, they are grouped into pedagogic bloc associated with a situation, eventually including first information input ideas. These pedagogical blocs are integrated in a framework of the evolution of a crisis in industrial environment inspirited by the hero's journey [7] in the same way as in game design or scriptwriting methodologies [23]. The hero's journey is organized around the transition from the common world to the unnatural/uncommon world where the protagonist of the story becomes a hero. A parallel can be made with the transition from normal to crisis mode. Therefore, the different step of the hero's trip can be adapted to fit with crisis situation process as seen in table 2.

Pedagogical blocs with prototype idea of scripting will be integrated in this framework and, based on the length of the exercise, will give a first view of how the exercise will process. The arrangement of each blocs is important because it will influence the dynamics and the stress of the exercise in addition to encourage the resolution of some problematics before other [19]. Further developments of "situation-task" is not possible before defining the "plot" of exercise, i.e. the accidental sequence.

The **fifth** step consist to select, with the contact person, the most adapted accidental sequence for the exercise. The accidental sequence means the causes of the accident, the accident, dangerous phenomenon associated, and people, environment, equipment or structure affected [24]. Accidental sequence should lead to "situation-tasks" and should be justifications for inputs helping trainee to do the wanted task.

At the **sixth** step, based on the hero's journey chronology, exercise is divided in 15 minutes sequences assigned to one "situation-task" where input leading to the task will be added as shown in table 1. Some sequence may not be related with a "situation-task" especially in introduction, transition, conclusion or build-up period.

Table 1. Block chronology of the exercise

Time block	Situation-task	Pedagogical target	Incentive / Perturbation

Table 2. Hero's journey step and crisis management process comparison

Hero's journey step		Crisis management process [25]	
Departure	The call to adventure	First step of the warning chain.	Warning
	Refusal of the call	Disbelief or minimization of the crisis. Fear to leave the normal operation mode.	
	Supernatural aid	There is no supernatural aid in crisis process. Nevertheless, during exercises, facilitation can play this role.	
	The crossing of the first threshold	Awareness of the gravity of the situation. Emergency plan "engagement" and reflex procedures.	
Initiation	The belly of the whale	Information and action flooding. Difficulty to picture correctly the situation.	Crisis management
	The road of trials	First decision-making and awareness of operational difficulties.	
	The meeting with the goddess	Meeting with emergency services and information exchange.	
	Woman as a temptress	Temptation to not act anymore, letting all actions to emergency services.	
	Atonement with the father	Communication with authorities, medias and higher hierarchic level.	
	Apotheosis	Expectation of change, improvement or the end of crisis. Domino effect if any.	
Return	Refusal of the return	Expectation of recurrence, domino effect or unexpected consequences. Stay in alert.	Back to the normal
	The magic flight	Last communications to authorities and media with, eventually press conference. Checklist verification.	
	Rescue from without	Other stakeholders close their crisis units and emergency services leaves plant.	
	The crossing of the return threshold	Report and debriefing	
	Master of the two worlds	Crisis unit closing	
	Freedom to live	End of the sequence	

For each time sequences, situation-tasks and pedagogical targets related are reported. In this way, the purpose of each sequence and reasons why specific task were chosen is not forgot. Then inputs leading trainees to do the task are chosen. Nevertheless, the choice of relevant and efficient inputs is not easy. Indeed, they must lead to the task to do but in a realistic and non-obvious way to keep trainees focused and in a "flow" state

[26]. It is the reason why proto-situation task should integrate staging ideas in the very first step of scriptwriting. Each situation-task stages the resolution of a problem by participants and can lead to different solutions as shown in figure 4. The situation is usually implied by dangerous phenomenon or its consequences such as a wounded person or damaged equipment, and the trainee's reasoning process can be helped by incentive (e.g. municipal authority asking a press statement) but can also be slowed down by perturbation [21] keeping the simulation challenging for trainees.

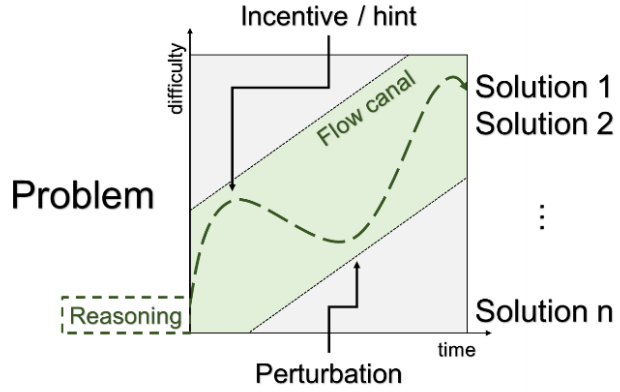

Fig. 4. Flow state diagram of a situation-task reasoning process

Once inputs are chosen, the way they will be injected into the system is defined. It could be trough a call, a direct interaction with someone from the peripheral audience or the use of an immersing device such as a sound speaker playing firefighters' siren. Direct interactions between target audience and facilitation are carefully managed because facilitator may influence target audience and decrease relevancy of observation. Nevertheless, in some situation, it is not possible to fully separate facilitation and target audience. In that case, interactions are limited – with only some fact presentation for instance – and are taken into account into further analysis.

In the end of this step, a precise timing with a 5 minutes meshing is established and inputs, recall, expected trainee's reaction and facilitators recommended reaction are specified in a table as shown in table 3. There is no need to over saturate trainees with inputs if it is not the purpose wanted. Indeed, communication between participants dispatched inside the organization will be important independently of the number of input. This precise table is then used to write the global script, which can be exposed to company's contact person for validation.

Once the global script written, come the **seventh** and last step of the design methodology. Each input is integrated into the corresponding facilitator's sheet with details related to the medium and the context of injection. These sheets can be split in two groups: those dedicated to mentoring peripheral public and give it a consistent – but partial – view of what happen and how they are supposed to react, and those dedicated to distant facilitation, simulating different stakeholder and controlling immersing devices. Facilitation sheets can also include a question/answer part to help facilitator to answer to possible questions from trainees. Nevertheless, these sheets cannot anticipate

all questions and reaction of trainees and facilitators should adapt the scenario to trainees' reactions.

Table 3. Precise chronology and input timeline

Time block	Situation-task	Pedagogical target	Incentive / Perturbation	Facilitator sheet	Precise timing
14h00-14h15	Warning chain. Crisis unit establishment	Procedures check	Imprecise alert Weak signals No feedback from operators	Intervention chief	14h00: Small event 14h00/5: Information check not successful 14h15: Warning confirmation. Major accident

3 Conclusion

This methodology allows to design efficiently emergency and crisis exercise for chemical industries. Nevertheless, it still needs a high level of competences to choose and arrange situations-tasks and therefore cannot be used by SHE manager. The next step of development of the methodology will consist in identifying a limited number of situation-task that can be staged in exercise to offer an user-friendly method for SHE.

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