An Application of the MEMbrain Training Module: Pre-hospital Rescue Operation.

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Abstract
A system for training in pre-hospital emergency management is being developed and the first version of a prototype has been completed. The training system fulfils the demands from the domain of hospital emergency planning centres and medical attendants concerning increased efficiency of rescue efforts. This includes enhanced first aid on site and improved overall co-ordination amongst the organisations involved in coping with emergency situations. The training system is based on the MUSTER[1] concept (Multi-User System for Training Emergency Response) which is used for the training module in the decision support system MEMbrain[2].

1. Introduction

The value of integrated tactical training of emergency management personnel coping with major emergency situations has been well-known and acknowledged for several years. The complete emergency management organisation is normally built up of various units, like the fire brigade, police, civil defence, etc. and each of these units takes care of maintaining and updating the skill of own forces via frequent exercises and drills. However, the interaction among decision makers from each of the units to obtain the optimal overall rescuing efficacy has revealed difficulties due to unclear definitions of authority or simply as a result of misunderstandings. Both of these may be and, to some degree, already have been remedied by integrated tactical training in form of table top exercises or large, expensive and, therefore, rather infrequent field exercises. The need for training has recently been addressed by developers of computerised training systems. Yet, these training systems, exemplified in reference 1, are nearly exclusively dedicated to emergency fighting units, such as the fire brigade, civil defence troops and police forces who have to cope with the control or extinction of emergency situations.

However, a relatively new approach - in Denmark - which is becoming normal practice at larger accidents, is to move the initial medical care away from the casualty ward in the receiving hospital out to the actual site of the emergency. This provides faster and, thereby, more efficient support to the casualties. Furthermore, it enables more efficient distribution of the casualties to hospitals with available capacity and appropriate expertise to deal with injuries than when casualties were taken to the nearest hospital, assessed, and then re-distributed to other hospitals as appropriate.

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This method of working is still new to most medical attendants who are not used to working out of their normal hospital environment and with less equipment, unlike the other rescuing organisations, e.g. the fire brigade and police forces, to whom on site operation is the normal situation.

Therefore, there is a strong wish in the medical domain to create and deliver training sessions which develop the skilful performance of its medical attendants in these new environments. This involves training in enhanced first aid and in certain aspects of the emergency management organisation, in order to fit in adequately with a tried and tested structure of command. These aspects include training in overview, disposition making, co-operation, communication, etc.

In Denmark about twenty anaesthetists and twenty orthopaedists - the doctors normally involved in the pre-hospital treatment of casualties - are educated each year. They are involved in one or two large training sessions which mainly cover the first aid aspects and involve field exercises which require a large number of people acting in various supernumerary roles. However, there is a need of such training sessions for updating the knowledge of 3-500 doctors each year and, therefore, a system offering an easier and more cost effective form of such training is highly desired.

2. The MEMbrain training system

Risø is a member of the MEMbrain[2)] consortium and responsible for - among other modules - the computerised training module to be included in the MEMbrain decision support system. Therefore, Risø has been working on a framework called the MUSTER[3)] concept, which is capable of configuring such a training system for various domains and situations.

In order to try out this framework on a real application and at the same time to fulfil the needs of the hospital domain, Risø started a co-operation with the 'Office of Hospital Emergency Planning' and some Danish hospitals using the MUSTER concept for real training set ups which complies with both of the requirements mentioned above, the first aid and the co-ordinating aspects.

The conceptual architecture of the training system is shown schematically in figure 1 indicating the various phases of functionality.

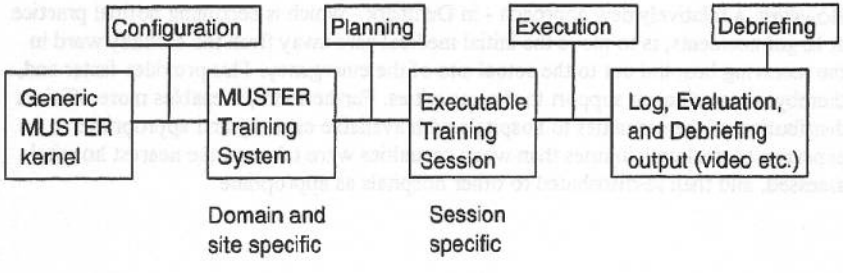

Figure 1. The various phases of functionality in the MUSTER concept.

The supervisor, who is being the person responsible for planning and executing the training session, carries out the following tasks in using the system for training and evaluation related purposes:

Configuration which consists of defining and implementing all features that are permanent for a site and for a particular domain. The result of configuration is a training system for a specific domain and a specific site.

Planning which consists of defining and implementing all features that are necessary for a specific session. The result is a definition of a training session that can be executed by the training system.

Execution which consists of monitoring the trainees, controlling their displays and their communications, performing the simulated emergency, managing the session, controlling resources, initiating domain events, sending messages, making pedagogical interventions, communicating with the trainees, etc. The result is delivered training and data to support the evaluation and debriefing phase.

Evaluation and debriefing which consist of analysing the training session and discuss with the trainees the decisions and actions undertaken. The result is, hopefully, improved performance in a possible future emergency situation.

The training system to be adapted to the hospital domain is being developed at Risø and must be able to train doctors at the site of emergency at three different levels: the co-ordinating doctor who has the task of obtaining and monitoring the number and the degree of severity of casualties and the need of vehicles for transportation of the casualties; the doctor prioritising the treatment of the casualties - the triage; and the treating doctor who offers first-aid on site, secures a safe transportation of the casualties and assures the highest efficiency concerning the distribution of casualties on the available hospitals. The first version of the system covers mainly the on site first aid training; the co-ordinating aspects, however, will be included in a later prototype.

It is intended, eventually in the long run, to develop a commercial training system for the hospital domain. The documented prototype developed at Risø will be combined with detailed user specifications and act as the input for a Danish software house, IFAD (Institute For Applied Data technique) which is responsible for the commercial version of the system.

3. Functionality of the pre-hospital training system

As mentioned above, the MUSTER training concept which was developed at Risø is not a fixed training set-up to be used in a specific domain or for specific training sessions; it is a framework in which various training set ups may be prepared each distinguished by specific needs and wishes. In order to make the system flexible, all parameters for configuration of the training set up are specified in an input file, based on which a selection of sceneries may be picked from a library of pictures illustrating, for example, a forest on fire, an oil port with burning oil in tanks or ships, derailed or in

other way crashed train wagons on fire or leaking toxic materials from damaged tank wagons, or areas partially under water due to flooding etc.

The computerised visual representation for the training session may be layered, with the overall site presented as the bottom layer, and superimposed a presentation related to the specific scenario, such as vehicles or buildings on fire, smoke fans covering more or less of the area and wounded people in the area.

Each selection of sceneries comprises an overview of the area and the situation, as well as zoom-ins and close-ups to provide details of importance to the decision makers for the emergency management. This can include, for example: where to select the location to which the casualties will be transported by fire fighters - who may be the only ones having equipment to work in the potentially contaminated area - while waiting for further treatment; where to select the location for gathering people who are victims of the accident - but able to convey themselves - in order to create a complete victim register; or where to select the location for the rescue vehicles, e.g. ambulances or fire trunks, waiting to get into action.

All parameters concerning pre-planned actions, like the number, location and time of appearance of potential casualties, explosions which are likely to occur if the correct actions are not taken within a given time, pre-planned changes of the weather situation etc., may be specified in the input file as initial parameters. Dynamic actions, however, must be allowed to interrupt the execution and allow the supervisor to interact with the scenario during the training session to modify the session according to the performance of the trainees, or to direct - if needed - the scenario along the lines dictated by the scope of the training session.

Likewise, the trainees must be able to influence the scenario interactively via their actions in coping with the accidental situation in relation to their responsibilities. The trainees as seen from the pre-hospital point of view are - as mentioned above - the co-ordinating doctor, the triaging doctor and the treating doctor.

The responsibility of the co-ordinating doctor is to be aware of the situation concerning the expected number and severity of the casualties by keeping contact with the commander in charge of the emergency, and to pass this information to the triaging doctor, in order to allow the triaging doctor to plan the activities on the location to which the casualties will be brought. Similarly, the co-ordinating doctor must also be in contact with the co-ordinating authority of the hospitals and the co-ordinating ambulance driver in order to allow them to arrange free capacity in the hospitals and sufficient capacity for transportation, respectively. It is very important in fact for the co-ordinating doctor to "keep ones hands in ones pockets" except for the use of communicating equipment, and to be beware of not becoming involved in any detail in the treatment of casualties and thus loose the general view.

The responsibility of the triaging doctor is to prioritise the casualties in groups in order to obtain the most efficient sequence of treatment. For the triaging doctor as well, the general view - now in a more limited area - is important; so, assessment of the casualties must be sufficient for prioritisation and no more and - as the co-ordinating doctor - the triaging doctor should not be involved in any detailed treatment of the casualties.

The responsibility of the treating doctor is to supply first aid to the victims, to stabilise them for the transport to the hospital, and to decide - and specify to the ambulance driver - the right hospital, in order not to waste important time. If this is not done clearly it can increase the risk to the casualty of being carried to the nearest hospital and then re-transported to an appropriate hospital.

In the training system the input for the co-ordinating doctor will be verbal information concerning the overall situation on site either directly, via radio or by walkie-talkie from the commander in charge of the emergency.

The input, in training, for the triaging doctor will be a visual impression of the casualties from pictures, e.g. in the form of photographs of made-up dummies, possibly with textual information needed for an expeditious assessment of the wounded persons, e.g. blood pressure, pulse or state of consciousness.

Finally, the input for the treating doctor will be pictures similar to the ones shown to the triaging doctor but with the possibility, by clicking with the mouse at various point of the body, to get more detailed information of the condition of the injured person.

This part of the prototype system which is dedicated to the three levels of medical attendants is mostly directed towards the first aid aspects of the training. However, the co-ordinating aspects, as seen from the point of view of the medical domain, will be integrated when running scenarios including the overall emergency management organisations. With such integration, all the emergency services' personnel potentially involved will be trainees who come together, each with their own information and priorities covering for example the chief of the fire brigade (concerned, say, about the task of coping with an escalating fire for which he needs the same firemen as the co-ordinating doctor needs for collecting casualties on site) or the chief of the police (concerned, say, about a major accident blocking access routes). In this situation, the co-ordinating doctor, who has the first priority of rescuing the casualties, must negotiate with the other decision makers in order to establish common agreement about the most efficient way of using the available resources concerning the overall point of view.

4. System architecture

In order to provide a flexible structure to the training system from the point of view of software development, the system will be built modular with the modules being integrated on an integration platform[4] as indicated on figure 2.

Casualty simulation may be developed as a separate module and, via the integration platform, it will send to the doctors the information needed for the assessment of the casualties, i.e. their condition and their response to specific treatments. The AMC (Acute Medical Co-ordination) module is the intermediate link between the hospitals and the emergency site. The AMC may, in a training session, represent the hospitals, or the training session could be enhanced to include the communication and negotiation between the AMC and the hospitals involved.

The logging module will log during the execution phase and present for the evaluation phase all informations concerning the events showing up during the training session, all the interactions of the supervisor and each and all of the interactions and efforts of the trainees. The log will be partly a complete, time sequential log, and partly logs dedicated each of the objects involved in the session, i.e. unveil the efforts of each trainee, the adequacy of each location, and the availability of, e.g., means of transportation.

The weather simulation and development of smoke or toxic plumes will run on a particular simulation and will be overlapped the scenery of the scenario by the visual presentation module.

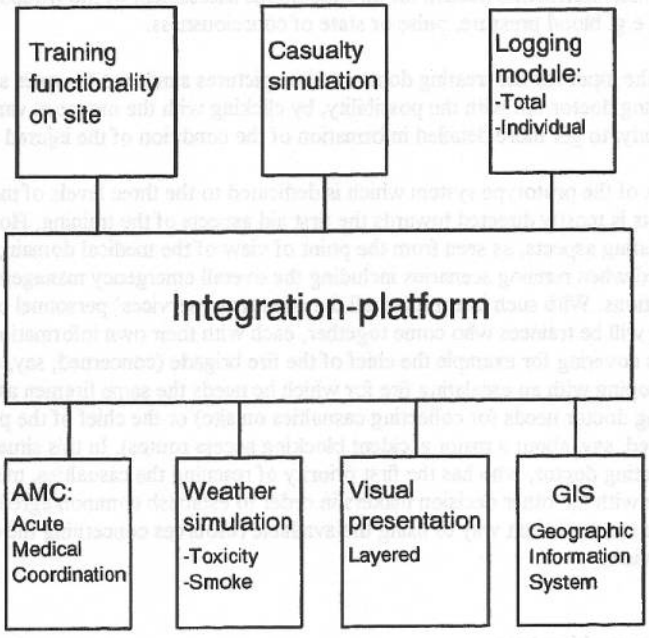

Figure 2. Various modules of the training system integrated on the integration platform

A GIS (Geographical Information System) may be available for the supervisor in order to allow a full overview of the complete area as well as the progress of the training session, including the position of specific locations, the use of resources etc.

5. Applications

The aim of the pre-hospital training system is to develop an illustrative prototype which is being prepared by Risø by the end of 1996, and a functional prototype, which is being prepared by IFAD, by the end of 1997. The latter, of which the validity has been assured through a very close co-operation with the hospital domain, will be

distributed among a number of Danish hospitals for testing and approval; it will be the basis on which the product will be matured and developed into a commercially available training module.

However, apart from the interest shown by the potential end-users of the system, the attraction to Risø - as mentioned above - has been not only to develop a training system for improving the pre-hospital performance in itself but, also, to take the opportunity to try-out, for a particular domain, the validity of the MUSTER training concept that will be included as the training concept in the MEMbrain decision support system.

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