META - AND CONTINGENCY PLANNING IN COMMAND AND CONTROL CONTEXTS

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ABSTRACT

Maintaining Public Order at large events such as crowd demonstrations is a complex activity involving logistical and contingency planning and requiring shrewd management of strategies and tactics. Developing such skills can be assisted by computer based methods and a simulation system CACTUS was designed to achieve these objectives. It has several features of interest including a digitised map which agents navigate, multiagent crowd models, time-line control to assist debriefing and graphical tools to guide the incident. The simulation permits multiple users to actively participate in the decision making, and if desired, the trainer can also shape and adjust the simulator, as it runs, in response to users decisions or to introduce other contingencies. The system is now being evaluated as part of training courses for senior police officers.

INTRODUCTION: THE TRAINING CONTEXT AND ITS REQUIREMENTS

Policing large scale incidents such as crowd demonstrations and marches is a considerable logistic exercise not only requiring contingency planning but sound strategic and tactical management. Errors of judgement may prove extremely expensive, and even endanger life. Furthermore, the resulting disorder can damage public confidence in the police and devalue the purposes of the demonstration.

Training such skills is difficult to organise and engineer. Managing demonstrations economically requires dispositions of appropriate police resources, an awareness of 'what-if' contingencies and a comprehensive strategic view of complex and dynamic interactions. Interpreting these scenarios gains much from previous experience. While tactical training can be arranged 'on the ground' organising authentic exercises to develop meta- and contingency planning skills can prove difficult and expensive. Simulation techniques can help to overcome some of these problems. Clearly the simulation should aim to be authenticate, and replicate, as near as practicable, the control room conditions and atmosphere of the real event. The decisions of the trainees and their consequences will need to be clearly observed and recorded, so they can be used in debriefing, and it would be valuable to have mechanisms for resetting the training simulation for a comparative re-running of alternative decision schemes. Also the trainer is likely to need opportunities to intervene either directly, or indirectly through management of the simulator. Since in the real situation different phases or aspects of the event are managed by different controllers, the system should accommodate multiple trainees able to communicate with each other.

Given these requirements computer based simulations, if they are appropriately designed, have much to offer, since they allow trainees to practice in a 'safe' environment but one which can generate some of the stress and the complexity of the authentic situation. To investigate the practicability and value of such methods, and in collaboration with the Metropolitan Police Office, a computer based system (CACTUS) has been developed to be used for training and, potentially, as an operational aid. The system covers both pre-incident planning with a testing of contingencies, and the management of simulated public order events with debriefing facilities. Its rationale and design are discussed in the following sections

SYSTEM COMPONENTS AND LEARNING ISSUES

In designing the simulator a possible approach is to represent through video public order scenarios composed of a calendar of events, in which trainees' decisions and their consequences direct them upon particular training paths. This conception, though achieving some realism, is limited by the range of pre-stored materials which place constraints on the trainer's modes of use and the customisations of the materials to suit particular needs and objectives. The approach followed in CACTUS was to develop computer models of crowd behaviours that response to what they 'sense' in the environment and the policing tactics which are employed. This should have added flexibility and lead to a system where trainers themselves are able to compose the simulation exercises. The major components of the system are: (i) a representation of 'the world' in which the event takes place, based on a digital map that features buildings of interest to the crowd agents, and the route of the demonstration; (ii) crowd and opposition groups that can move about the map, and to which probabilistic behaviour networks are attached; (iii) police units which can navigate the map and be given particular functions and corresponding low-level autonomous behaviours that react to crowd and other group behaviours; (iv) a controlling 'referee' that arbitrates the consequences when groups (including the police) have conflicting behaviours and goals; (v) communication channels by which the trainee can instruct and secure feedback from the simulated police units, and links to trainees dealing with other aspects of the event; (vi) interfaces through which the simulation can be managed by the trainee, and the 'world' observed and particular interventions made by the trainers, and (vii) time-based record keeping facilities for dynamic debriefing.

In designing such simulations it is useful to consider how simulations support learning. Craik (1943) suggests that learners translate the 'external' objects and events with which they interact into internal (mental) models. Through reasoning, correspondences are noted between these mental conclusions and the time-based events in the simulated world. Norman (1983) in developing these ideas makes distinctions between: (i) the target system (eg the simulator) the learner is using, (ii) the conceptual model developed by the designer that underpins the target system, and (iii) the system image which the device (eg. the computer based simulation) conveyed to trainees will, in turn, influence their mental models, and the ways they understand the domain (Norman 1983; Staggers and Norcio 1993). These knowledge representations of the designer and trainee mediated by the simulator should be congruent for efficient learning, hence the trainer should be a key partner in the design with the simulator being able to be customised to particular views, and the conceptions of the trainees should noted through formative evaluation studies.

Sunderstrom (1993) makes the point that in control room management of complex processes what information is available (in the simulator) in relation to the trainee's tasks, how it is presented (through the interface) and when it is accessible all influence the development of mental models and understanding of trainees, and hence system design should be based on the information and knowledge users require and what presentation formats best support its use. The decision making task requires trainees to interpret the state of the world through time, to make interventions to achieve anticipated and desired effects, and to communicate relevant consequences to other users managing other aspects of the event. The interface has to facilitate these requirements, aiding interpretation by subsuming detail (of behaviours and events for example) under higher levels of granularity (shown perhaps by colour coding or by icons) and assisting interaction through direct manipulation that has shown to have considerable advantages (see for example Eberts and Bittianda (1993)). Where distinct functionality is given to different types of interaction (eg. map interpretation, instruction giving, or receiving messages) then the interface can have greater heterogeneity in its design (Avours, van Liederkerke, Lekkas, and Hall 1993). The system should also be capable of adjusting (for example through its task complexity or through its interface characteristics) to debriefing levels of trainee competence (Trumbly, Arnett, and Martin 1993). All these considerations were taken into account in the CACTUS designs, and its features and modes of use are now outlined.

SYSTEM IMPLEMENTATION AND MODES OF USE

CACTUS was implemented on a UNIX SUN-Sparc Workstation, but the client/server architecture allows Windows-based PCs to act as additional trainee stations. Two interfaces on the simulation have been developed, one for the trainer who will specify the simulation exercise and monitor and steer, as necessary, its application and debriefing with users, and a trainee's interface to allow map interpretation, and a log of the commands and reports.

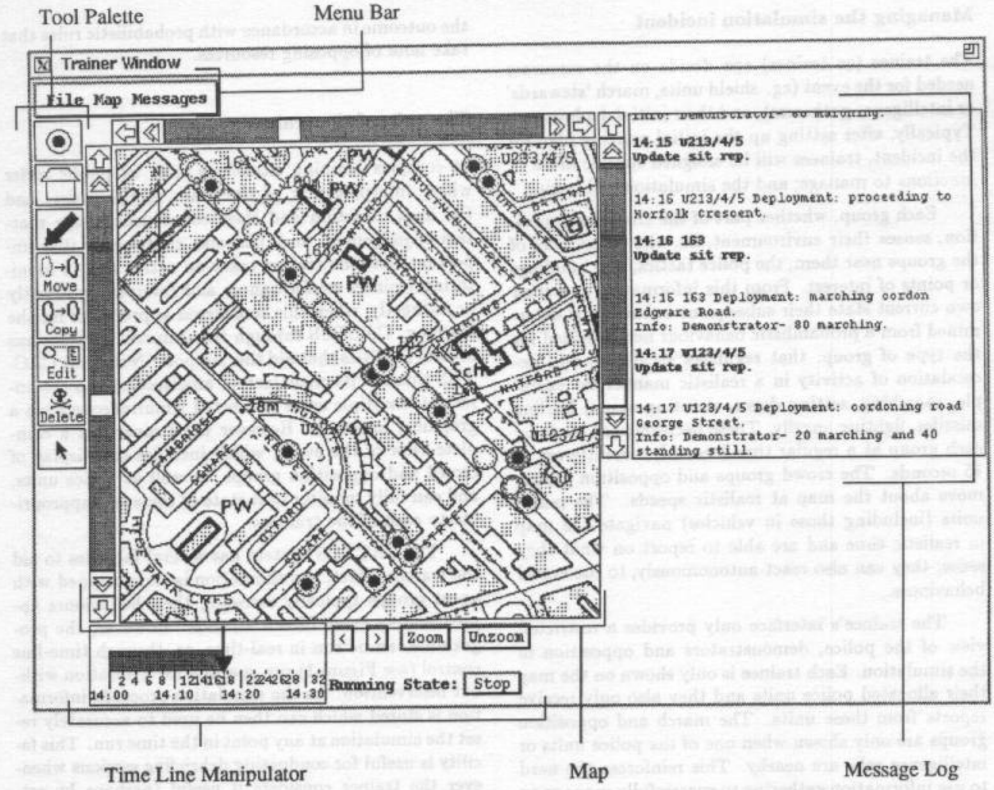

Figure 1: Annotated Trainer Interface

Pre-incident planning

In CACTUS the trainer is able to specify the route on the digitised map by indicating the points through which the demonstration march is expected to pass. The trainer will also specify the number and type of crowd elements making up the march (eg. peaceful or excited groups). Using the trainers' tool palette (see Figure 1), buildings or points of interest to the marchers or opposition groups or police, can be marked (eg. politically sensitive buildings or scaffolding that might prove a source of weapons, or shops that might attract looting). The palette also enables groups to be created on the map, which is used to specify the initial location of opposition groups.

Given this information the system is able to help by working out the expected time of completion of the march along the route, and the actual number of police engaged. This permits a rough estimate of the 'resource cost' of that particular policing strategy to be estimated. Thus CACTUS can become an aid to the pre-event planning and requirement specifications for actual events as well as serving as a training aid. For example the trainer (or the trainees) are able to set out their decisions and justify them, as necessary, and also try out "What-if contingencies" eg. if particular opposition groups are strengthened or the march is hijacked or a car accident occurs on the route. The simulator can be run against these particular occurrences and their consequences for the policing strategy noted.

Managing the simulation incident

The trainee (or trainer) can decide on the resources needed for the event (eg. shield units, march 'stewards' or intelligence gatherers), and their initial deployment. Typically, after setting up the initial policing plan for the incident, trainees will be assigned specific areas or functions to manage; and the simulation will begin.

Each group, whether part of the crowd or opposition, senses their environment, i.e. the behaviours of the groups near them, the police tactics, and buildings or points of interest. From this information and their own current state their subsequent behaviour is determined from a probabilistic behaviour net, specified for the type of group, that regulates escalation and de-escalation of activity in a realistic manner for example, marching, setting down, shouting abuse, hurling missiles, fighting angrily. These decisions are made by each group at a regular time interval, currently set at 15 seconds. The crowd groups and opposition groups move about the map at realistic speeds. The police units (including those in vehicles) navigate the map in realistic time and are able to report on what they sense; they can also react autonomously, to the crowd behaviours.

The trainee's interface only provides a restricted view of the police, demonstrators and opposition in the simulation. Each trainee is only shown on the map their allocated police units and they also only receive reports from these units. The march and opposition groups are only shown when one of the police units or intelligence cells are nearby. This reinforces the need to use information gathering to successfully manage an incident. Restricting the view to only their 'own' units is intended to promote collaboration between trainees so that they don't work in isolation.

Trainees have to monitor and interpret the event, receiving or requesting information of the crowd state from police units and intelligence cells. This information is recorded on a Message Log (see Figure 1) and in response the trainee can make strategic and tactical decision and send the necessary instructions to the police units (eg. form shield cordon). The chosen units take up these actions in real time. The communication from trainee to police units can be achieved through an on-screen message panel, or if preferred, by sending the instruction via radio-telephone to the trainer who then acts on the user's behalf. In this way the simulation exercise proceeds with trainees also relaying appropriate messages to those users managing other stages of the demonstration march. When there are conflicting goals between crowd groups, hostile elements, or police units, CACTUS employs a computer referee to decide the outcome in accordance with probabilistic rules that take note of opposing resources.

The role of the trainer

In complex training situations such as public order where interpretation of the state of the event, and the lines of action and their consequences, are matters of judgement and, perhaps, controversy it is important that the trainer takes an active role in monitoring trainees performances and intervening directly or indirectly, when this considered appropriate for the learning. CACTUS through the trainers' interface has several facilities that aid this support. Note that CACTUS through its client/server architecture can accommodate multiple users connected simultaneously via a graphical interface. However the trainer has a complete view of the event, which includes the display of crowd and opposition groups, as well as police units, and can fully monitor that state of the event appropriate to each of the trainees.

The CACTUS System has several facilities to aid the trainer. First, the simulation is time-stepped with agent groups typically assessing their behaviours approximately every fifteen seconds. However, the programme can be run in real-time, or, through time-line control (see Figure 1) run speedily for a duration without intervention. As the simulation proceeds information is stored which can then be used to accurately reset the simulation at any point in the time run. This facility is useful for conducting debriefing sessions whenever the trainer considers it useful (perhaps by setting the simulation at any earlier time point to discuss how trouble arose, and for the simulation to be rerun from that time-point with a different action plan, or to forward-run the simulation to underline particular weaknesses in a policing or information gathering strategy). The sequence of state information of the simulation can be stored in a file and then recovered to continue the exercise at a later date or to store as an example in a case-study archive.

Second, to help the trainer in interpreting the complexities of the event, each type of agent group (shown on the display screen as a circle at their location on the map) is colour coded to indicate if it is a police, crowd or opposition element. Further each group icon is surrounded by a halo which, as the behaviour becomes more aggressive, is coloured a deeper shade of red. Hence the trainer can quickly identify developing pockets of discontent.

Third, the trainer can place icons from the tool palette on the map and attach short comments, if necessary, to describe a particular type of hazard or area of interest. This can be used as an attention note for the debriefing, and the trainer can also place instructional comments as marginal notes in his message log. It can also be used to introduce events not directly supported by the simulation, for example to indicate a fire that the march would have to be routed round.

Fourth, the state of the simulation can be altered by the trainer in ways which are not directly perceived by the trainee. For example, opposition groups can be moved or other groups added to the scene. These groups will, no doubt, be reported by police units to the trainees log in due course the trainer himself can add reports, for example as a bystander or as a police unit and by these methods latent weaknesses in the policing strategy can be exposed or the trainees' attention drawn to them.

Adapting to the trainee

These facilities allow trainers to manage the pre-event planning and contingency testing, the management of the event and the debriefing, in a variety of ways which suit particular objectives and the experience of the trainees. Indeed a wide variety of types and complexities of events and incidents can be presented in such training exercises. The simulation can also be organised with small groups, rather than individuals, managing the decision making at each workstation.

Additionally trainees can have access to other supporting material. Hypermedia case studies of previous incidents are being stored in an archive, and linked to this material is information to configure the simulation to match significant events during these incidents. Running the simulation within these prescribed contexts should also provide useful insights. Perhaps, more importantly, these case studies which illustrate previous experience in the disposition of resources and tactics can be used as operational briefing aids for events that take place regularly and follow the same or similar map routes.

Evaluation and Extension

CACTUS has undergone its initial trials and now is a training component in courses for senior police officers. Evaluation data is being collected, and the questions of interest include the ways trainers decide to use the simulator, and the facilities they employ in pre-incident planning, event management and debriefing. Similarly there is interest not only in the performances of trainees, but in their views of using the system and those facilities which they consider improve their planning and decision-making capabilities.

Current consideration is being given to the ways similar design principles could be applied to the management training of other emergency situations where many types of interacting resources require logistic and contingency planning, and where agent behavioural networks could be applied. If CACTUS proves successful then similar facilities and methods can be brought into other simulations and hence provide greater flexibility to instruction, and more adaptive trainee and trainer support.

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