Chapter 11 – FROM INDIVIDUAL TO GROUP BEHAVIOUR

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11.1 INTRODUCTION

Human factors are often considered at the individual level but military operations are typically a team effort. Early analytical simulation of large-team, force-on-force engagements (Lanchester, 1916) contained little that could be considered Human Factors. This trend seems to have persisted into more modern simulations despite an interest in small team activities within an operation. Even at the high aggregation levels, human aspects of collections of individuals such as morale and commitment are thought to play a significant role in areas of interest to Operations Research.

11.2 DISCUSSION

At the small team level (fire team, platoon, company, flight crew, squadron, etc.), individual Human Factors are still relevant (for example, workload, fatigue, thermal strain, etc.), however, other properties, characteristics and behaviours appear that experts feel are important to operation success (for example, morale, mutual support, commitment, etc.). While these are still attributes of individuals, they arise because of the interaction of the individuals in the team in their coordinated pursuit of a common goal. Other behavioural markers are also present in small teams that may be overlooked at higher levels of aggregation, but are important to capture for team simulation. These behaviours include communication and feedback, mutual support (backing up) and task sharing, team assessment and monitoring of teammates, to name a few.

Teams represent an additional level of complexity over individuals so it is reasonable to be concerned about appropriate representation when we have trouble modelling individuals, but if the degrees of freedom of the analysis can be controlled, and the subsystems suitably characterized, then team modelling seems feasible. Brad Cain suggested that the concern about the additional complexity doesn't necessarily follow as, by analogy, many aspects of fluid dynamics may be captured at a continuum level without modelling the dynamics of individual molecules. This reflects capturing individual HBR effects, such as workload, as team latent variables that can be considered factors at an aggregate level, much the same as viscosity reflects the exchange of momentum of molecules for fluids at a continuum level. Andy Belyavin remarked that individual representation may be necessary to detect certain phenomena but there should be nothing to restrict a mixture of aggregate and individual entities as long as the interaction phenomena are represented appropriately.

Team models can be conceived as a collection of cooperating individual models or as a team-entity that entails no distinct representation of its constituent members. Each representation approach has implications for the level of representation used and the human sciences requirements. Melanie Linde reported that some combination of these two approaches has been successfully used in Germany, where communication and group reasoning within teams has been represented as a "disembodied leader" construct. The "disembodied leader" – assumed to be a non-human, mechanistic process model – may preclude the interaction of operator states such as workload effects on group reasoning and leader activities. If timing is critical in the analysis, the disembodied leader approach also may cause problems representing where group knowledge lies within its member. It was also observed that "blobs" with disembodied leaders would not be appropriate for modelling the impact of complex interfaces. Nevertheless, the disembodied leader approach may be a suitable approximation when the desired level of granularity of the analysis is somewhere between a collection of individuals and the team entity level.

The collection of individuals approach allows more detailed models of the individual behaviours, capabilities and limitations. Conceivably, the collection of individuals approach can provide insight into why team performance is good or breaks down but this in turn requires more effort to model the interpersonal interactions; that is, the teamwork. But Rob West reported their observation that teamwork is often characterized by frequent interruptions and task switching, features that are not well captured by standard GOMS or task analytic approaches that focus on individual jobs. These analytical techniques, while capturing the task-work often fail to capture the team-work that leads to role and resource switching. Such phenomena might be better captured with a mixture of HTA and TNO's pandemonium model, or some other task prioritization scheme, to reflect changing attentional foci of team members.

Laurel Allender suggested that dynamic network analysis might be a useful approach to capture interactions between team members as it measures both events and the content of any communications and enables analysis of communications in detail. The collection of individual models need to include the team tasks and include task scheduling that that dynamic network analyses captures to represent the ability or tendency of individuals to deviate from a plan in a constraint based system by opportunistic replanning.

The team entity modelling approach focuses above the level of the individual behaviours or abilities, and is the mainstay of many Operations Research military analyses. Rob West observed that details of the individual actions within the team by its members are typically ignored in organisational dynamics modelling. Organizational modelling is focused at a high-level of abstraction, examining the effects of performance variability, not why the performance actually degrades. The team entity approach loses some of the resource management constraints (such as cognitive workload) simplifying the modelling, but it introduces new latent variables that are team characteristics. These latent variables are often not formally defined – Are there representative models of how these latent teamwork aspects such as communication and situation awareness, perception and workload evolve with events?

There seemed to be a consensus that we can define the essential aspects of team performance that can be modelled and measured. Carol Cooper-Chapman reported that the UK has developed conceptual models of how some of these factors interact and the dstl work on STORM has explored social and cultural effects through formal models in the analysis of collective behaviour. There appears to be a need to delve further into the team research field to see if there are sufficient data that formal models can be further developed, establishing the distinction between Teamwork (interactions between team members that are an overhead) and Taskwork (individual work typically captured by GOMS-like analyses).

Team modelling might benefit from experimentation in games (such as DARPA's "Realworld[1]" and Breakaway's "A force more powerful[2]". Bob Foster noted that NATO has collective training centres that might be a good source of observational data to capture the interaction of different cultures in a team of individuals (command centre) or the cooperative activities of brigades from different nations.

It was thought that many of the aspects of crowds can be modelled at the fluid dynamics level. There has been some success in inserting beliefs and states into crowds to modify their behaviour. It was noted that crowds might be considered an extreme form of organisations and Old Dominion University (among others) has looked at the roles of individuals in the crowd. A military organisation might be represented as a hierarchy of small structured teams but the modelling problem area lies between these two extremes – "edge" organisations – where individuals in the crowd play roles as do small groups that might have a team attributes yet their interaction in the crowd entity is uncoordinated. Jerome Levesque described some preliminary work to develop a synthetic urban environment with crowd modelling to study and train for emergency response (discussion in section 4 below) that would benefit from data derived from observing domestic crowds (such as Old Dominion's research) as well as from NATO training centres if they engage in Effects Based Operations training.

11.3 CONCLUSION

There seemed to be a consensus that team modelling is viable with current technology. The HBR modelling community could, with some additional study, define the pros and cons of the various approaches to team modelling: capturing teams as blobs, collections of cooperating individuals or some combination of the two. Such a study would serve the M&S community, making recommendations about the suitability of each method for different purposes. Unfortunately, there doesn't seem to be a ready source of these pros and cons so some additional study is required to elicit this information from users of these techniques or by a team modelling panel. There was no indication of whether these approaches are affordable, but since many organizations are engaged in some form of team analyses, it would appear that some levels of representation are affordable. Validation of team models remains a tricky issue, although, as previously suggested by Lochlan Magee, transfer of training may provide a methodology for validation at some practical level.

11.4 SESSION RECOMMENDATIONS

1) Develop guidance to the M&S community on the appropriateness of various team and crowd modelling approaches to application areas.

2) Explore how task-analytical techniques can be extended to include teammork to support modelling teams as collections of individuals.

3) Document formal models that attempt to capture the effects of team and crowd latent variables on behaviour.

4) Explore using NATO training facilities as a source of data to support team modelling.

[1] http://www.darpa.mil/ipto/programs/real/index.htm

[2] http://www.afmpgame.com/

11.5 PRESENTATION SUMMARIES

CAMICS: Civilian Activity Modelling in Military Constructive Simulation

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This is a summary for a project that has started recently (June 2006). It is funded by the Centre for Operational Research and Analysis (CORA), a research organization part of Defence Research and Development Canada (DRDC). Our goal is to use the current knowledge in human behaviour representation and traffic modelling to implement a model of civilian population activity. The model will be used in constructive simulations for training and experimentation.

11.5.1 Aims

To develop a software model of civilian activity for military synthetic training environments, with a focus on urban areas.

To implement behaviours that are coherent with current literature and research in psychology and routing algorithms that reproduce basic urban traffic features.

11.5.2 Background

Simulations such as OneSAF, JCATS, and JSAF are currently used to represent a wide variety of traditional operational and war fighting scenarios. Recently, simulations have begun to be used to train for counter-insurgency, urban peacekeeping, crowd control situations, and other non-traditional operations. As a consequence, new models have emerged that attempt to simulate crowd and group behaviours (e.g., Crowd Federate™). Scenarios set in urban environments do not always involve crowd confrontation though. To our knowledge, none of the current models deal with normal daily activity, such as city traffic and busy street corners, or with crowd formation itself.

Existing crowd models often attempt to use "crowd psychology" as the basis for controlling simulated crowd behaviours. However, crowd psychology is mainly exhibited through varying levels of crowd aggression. The models track individuals within the crowd, but limit the behaviours depending upon initial group assignment (e.g., an agitator group). That approach cannot be applied to a model that would include normal daily behaviour, where each person remains driven by individual goals. Modern psychological research strongly suggests that each person maintains individual cognitions, personalities, and beliefs, (including religious and cultural ones), while engaged in group behaviours. Each person evaluates the nature of the sub-groups, the leadership, group structure and size, and continually examines possible situational factors that may influence their individual actions. This suggests that normal individual behaviours and group behaviours could be included in a single model.

In an urban context, human circulation by foot is coexisting with normal vehicle traffic. Fortunately, sophisticated models already exist to model vehicle routing, and the implementation of only a few basic rules should be enough for the training model we propose. On the software side, packages developed for the game industry, such as AI.implant™, now allow agent-based models of civilian activity to be built easily, including behaviour models and vehicle routing.

The project aims at providing the CF with proper models of civilian activity for constructive simulation environments, with a focus both on training and experimentation. It is a collaborative effort among the disciplines of psychology, computer science and military operational research.

11.5.3 Project Description

This project consists of two main branches:

1) Survey of current research covering individual versus collective behaviours, as well as urban traffic; and
2) Implementation of the models in a software simulation to use in constructive simulations.

The progress of these branches will overlap in time. It is planned that a working software prototype will be developed rapidly within the first few months of the study, and be improved subsequently as research progresses. The full research program would eventually span a 3-year period, each year adding an increment of functionality and reliability to the model, including an extensive validation process. In the first year it will be necessary to build the initial version of the software and implement basic behaviour and traffic models.