Chapter 13 – CONCLUSIONS

13.1   SUMMARY

The two days of collegial discussions on Human Behavioural Representation issues seemed to be a successful forum for the exchange of ideas and exploration of concepts. The focus on plenary discussion with short presentations seemed to be well received and there was extensive participation in the discussions by all of the attendees.

There was general agreement with the points of view of HFM-128 approach to documenting the human factors of HBR and that the community seems to be on the right track. Although progress in modelling human factors has been slow over the past decade, other forums such as BRIMS[1] and the CogSci[2] conferences have been reporting a number of theoretical and applied papers on human behaviour and performance modelling. While we are still a long way from turnkey models of operators, the consensus that various modelling approaches are useful gives confidence to move ahead in the field from a variety of perspectives.

Situation awareness and workload are concepts that are intuitive to the military client, yet they are not necessarily useful as a scientific concept that should be modelled. However, metrics of such concepts may be generated by models to assist interpretation of the model's performance predictions.

A modular approach to modelling human activity seems to be the norm, lending itself to inclusion of moderators while attempting to simplify the complex field of human cognition. The human cognitive and performance modules benefit from an abstraction layer that is an interface between the modules and the modelled environment, allowing models to be reused across similar applications, requiring principally minor changes to the interface layer.

When going from individual HBRs to team and larger unit characteristics, one cannot simply link the models and expect to get plausible behaviour. There are additional behaviours and goals that characterize groups that need to be added to the model knowledge base.

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[1] Behavior Representation in Modeling and Simulation: http://www.sisostds.org/.

[2] Cognitive Science Society: http://www.cognitivesciencesociety.org/cogsci.html.

13.2   RECOMMENDATIONS OF HFM-143 SPECIALISTS' MEETING ON HBR IN CONSTRUCTIVE SIMULATION

	General	To R&D Community	To NATO
1	Develop a capability to model non-traditional military activities such as humanitarian aid and state reconstruction. These activities are increasingly becoming the mandate of the military, OGD and NGO as a result of the 3-Block war concept and Effects Based Operations with the intent of predicting group and population reactions to events.	Develop formal modelling techniques to represent effects on organizations and populations as well as individuals that allow for generation and analysis of chaotic behaviours (small cause, large consequences).	Hold a joint meeting of SAS-053, HFM-128 and other interested parties to look for synergies arising from collaboration on HBR issues in NATO M&S with the intent of establishing a multidisciplinary panel to define the scope and requirements for constructive modelling of Effects Based Operations, including members from SAS and HFM currently working on HBR.
2	Advance the state of the art in HBR such that analysts can self-author behavioural models for CGF/SAFs.	Develop task representations that are compact in specification and show behavioural richness both by reactivity and proactivity. Continue the trend toward modular HBR systems and cognitive architectures to promote reuse and ease of refinement of models.	
3	Educate stakeholders in proper use of study design and analysis.	More exchanges between military customers of HBR and modellers to get an understanding of what is required from both perspectives. Clearly establish the constraints and approximations used in a model to determine the range of applicability, or its accreditation for use.	Organize a meeting in which military M&S stakeholders collaborate to integrate human factors into simulations. Develop a NATO checklist of human factors and document why each factor should be included as a means good practice, extending this into a guided interview that will help frame the model space.
4	Validate models and document their range of applicability.	Develop procedural and statistical methods of performing validation of models. Note best practices for gaining insight into behaviours and performance as well as techniques to quantify goodness-of-fit.	Collect and publish data that can be used to build and validate HBR suitable for military M&S.

	General	To R&D Community	To NATO
4		Establish public datasets from a wide range of tasks in order to objectively establish the broader validity of the cognitive architectures and HBR systems.	Promote the sharing of databases of behaviour and performance observations that can be used to shape models based on doctrinal procedure rules to promote more plausible behaviour. This could possibly be done in conjunction with the HBR Virtual Institute. Provide a mechanism to capture operational data that can be used to build and validate higher level models. Recommend the use of the NATO training facilities to collect data on high level C2 processes.
5	Develop a means of introducing plausible variability into HBR through the use of learning and the introduction of formal models that capture within and between individual variability or error.	Introduce factors such as learning (functional and procedural relationships), experience, context, goals and emotions into modelling operator performance. Define the different operator parameters that need to be considered for the modelling of performance and behaviour common for military operations. Define how these relate to the moderators of interest. Split sources of performance variation in traits (moderators, constant during the simulation period) and states (dynamic outcome based on state variables). Investigate if a similar approach to the successful use of state variables in physiological performance can be applied to states in the cognitive and emotional domains.	Assemble and make public an electronic library of moderator models and their effects on performance (preferably open source) that analysts can use in HBRs, providing validation details and suitable application of the models, possibly in conjunction with the HBR Virtual Institute.

	General	**To R&D Community**	**To NATO**
5		Develop or document formal models of emotion and motivation based on models from the social sciences that can be integrated within current HBR architectures.	
6	Development of an open source modelling environment that could evolve into an industry standard for the interface of HBR to other simulations.	Define the architectural constraints for implementation of state variables and performance shaping functions in the cognitive and emotional domains. Develop middleware that facilitates cross-HBR comparison. The HBR R&D community would likely benefit from a better understanding of productive methods for comparing models across architectures and comparing architectures.	Development of a hierarchical human HLA FOM or a similar interface specification that meets the foreseeable requirements of NATO's M&S activities. Document modelling synthetic environments, HBR architectures and models that currently support non-kinetic warfare, including social-cultural effects typical of post-combat reconstruction, noting extensions that would be required to make other products currently in use applicable to cost effective EBO simulations.
7	Improve the HBR element of team and group models.	Develop guidance on suitable means of modelling the way individual behaviour should be aggregated at team and larger unit level. Document descriptive, conceptual and formal models that attempt to capture the effects of team and crowd latent variables on behaviour. Develop guidance to the M&S community on the appropriateness of various team and crowd modelling approaches to application areas. Explore how task-analytical techniques can be extended to include teamwork to support modelling teams as collections of individuals.	Build upon NATO/RTO panel studies on teams and C2 modelling to identify formal models of teams and crowds as well as the latent factors that characterize groups.