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# USING A GENETIC PROGRAMMING APPROACH TO MISSION PLANNING TO DELIVER MORE AGILE CAMPAIGN LEVEL MODELLING FOR MILITARY OPERATIONAL RESEARCH

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## ABSTRACT

Defence in both the UK and the US is committed to innovate in order to stay ahead. This implies the need for supporting analytical tools at least as adaptive in their focus as the potential change to the military system of systems that such innovation may suggest. Current approaches to modelling and simulation (M&S) produce monolithic, user scripted, models that are not well suited to rapidly assessing innovative ways of operating. In the UK a simulation toolset has been developed to provide the necessary adaptability, enabling new simulations to be rapidly produced. This toolset contains a modular mission planner to automate generation of courses of action in what are potentially very different ways of doing business.

## 1 INTRODUCTION

In both the UK and the US the need for defence to cost-effectively innovate has been formally recognised (MOD 2016). While an initial assessment of the potential of new ideas can be made through a paper based assessment, the emergent consequences of these ideas can only formally be tested through simulation. This is due to the complexity of defence planning, the diversity of situations that it is required to address and the need to situate new ideas holistically at the campaign level.

Standard approaches to campaign level modelling deliver scripted monolithic simulations that are slow to develop and difficult to change. These standard approaches thus lack the qualities necessary to support a culture that is "innovative by instinct" (MOD 2016). Dstl research has been working to change this situation through developing a toolset for rapidly producing simulations that are designed to adapt (Glover & Toomey 2012), along with a Mission Planner which uses genetic programming (Lucek & Collander-Brown 2014) to automate decision making within such simulation.

## 2 A GENETIC PROGRAMMING APPROACH TO MISSION PLANNING

To overcome the limitations of scripted approaches to Mission Planning in simulations, Dstl, in cooperation with industry, has developed a number of automated decision making algorithms (starting with Moffat 2002). These algorithms rely on a computer program being able to recognise what *militarily credible* behavior is. Where *militarily credible* is defined by the criterion "Could a military planner have reasonably reached the same decision given the same information?" and the requirement that *requisite variety*, the variety of credible responses by such a planner, is maintained. This paper describes the progress Dstl has made to define *militarily credible* behavior for specific problems, outlining the challenges which remain in more general cases.

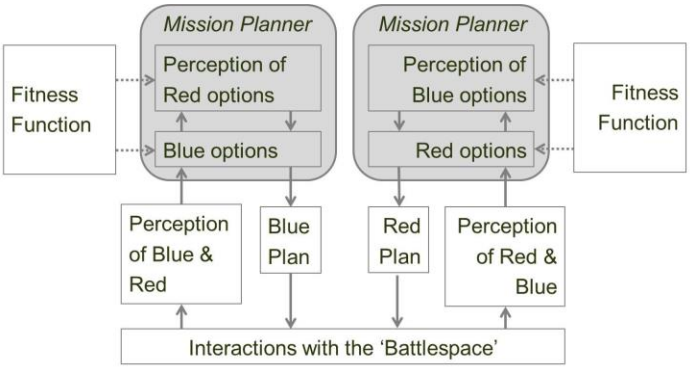


Figure 1: Mission Planner Key Conceptualisation

The main elements of this Mission Planner are illustrated in Figure 1 (above). The modularity of this design enables new 'fitness function' describing the planning criterion to be easily substituted. Thus far a means of constructing a militarily credible 'fitness function' has been defined, the effects of which have been tested against a previous scenario. Initially the criteria selected were too risk adverse and both sides simply hid. The second iteration of the 'fitness function' led to one side revealing its locations as the simplest way to stimulate the opposition to reveal theirs. The third iteration produced more nuanced interaction, as a result of which we realised that linked activities needed to be evaluated together, otherwise the genetic programme proved very inefficient at exploring the solution space. The resultant 'fitness function' is being tested against a current but previously analysed scenario, to assess the extent to which 'fitness function' applied to the same model deliver the intended effect in different scenario.

When we are content with our advice on developing 'fitness function' for Mission Planning, we will apply our Mission Planner to a scenario that has not previously been analysed. This will enable an initial evaluation of the issues to be planned against, the risks inherent in the baseline and the treatments that may mitigate these risks. This evaluation will be subject to validation by independent comparison and military review. Given a satisfactory outcome, we will then investigate the treatments identified.

## 3 SUMMARY

This case study has described work to enable defence simulation and consequent analysis to support a culture that is 'innovative by instinct'. It is intended to present the results of this work to WSC 2018.

## ACKNOWLEDGMENTS

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