

[dstl]

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Ministry
of Defence

A UK perspective on campaign level constructive simulation

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Overview

- Why campaign simulations
- Complexity in military operations
- Rapid model development
- Exploration of potential solution space
- Analysis of large data sets
- The future of modelling

Why Campaign Simulations

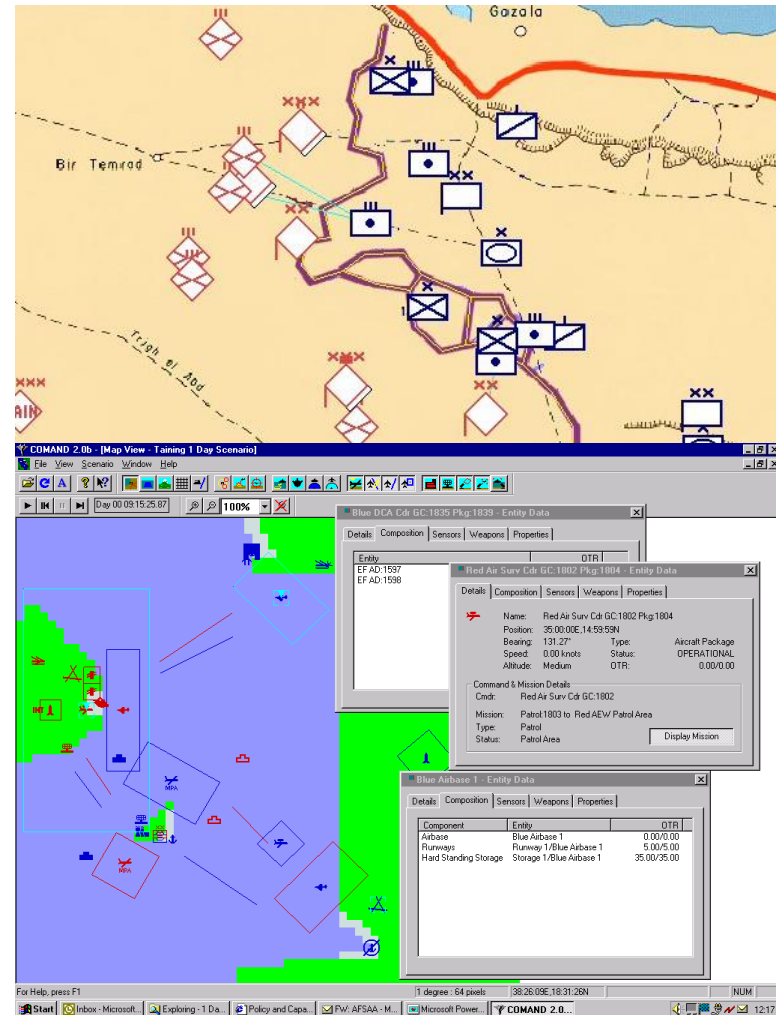
- Ultimate aim of Operational Analysis is to provide advice to decision makers
- Decision makers need to know what the critical “capabilities” are to allow campaign success
 - What is actually required
 - What level of performance does it have to achieve
 - Relative to likely opposition
 - How much risk is being taken
- Fundamentally how does a decision impact the system of systems

Campaigns are complex

- Thousands of interacting parts
- Massive feedback potential
- At least two sides actively trying to disrupt the other
- Change in technology and legal frame work subject to (often rapid) change
- Complexity needs to be reflected in models
 - Simple Data – Complex Model
 - Simple Model – Complex Data

Traditional Campaign simulations

- Large
 - Typically 100,000s of data items needed to feed them
- Complex
 - Very large number of potential interactions
- Bespoke
 - Designed with a specific set of assumptions and allowable behaviour
 - Hard to modify
- Large training burden
 - Can take years to master the complexity



Traditional Campaign simulations

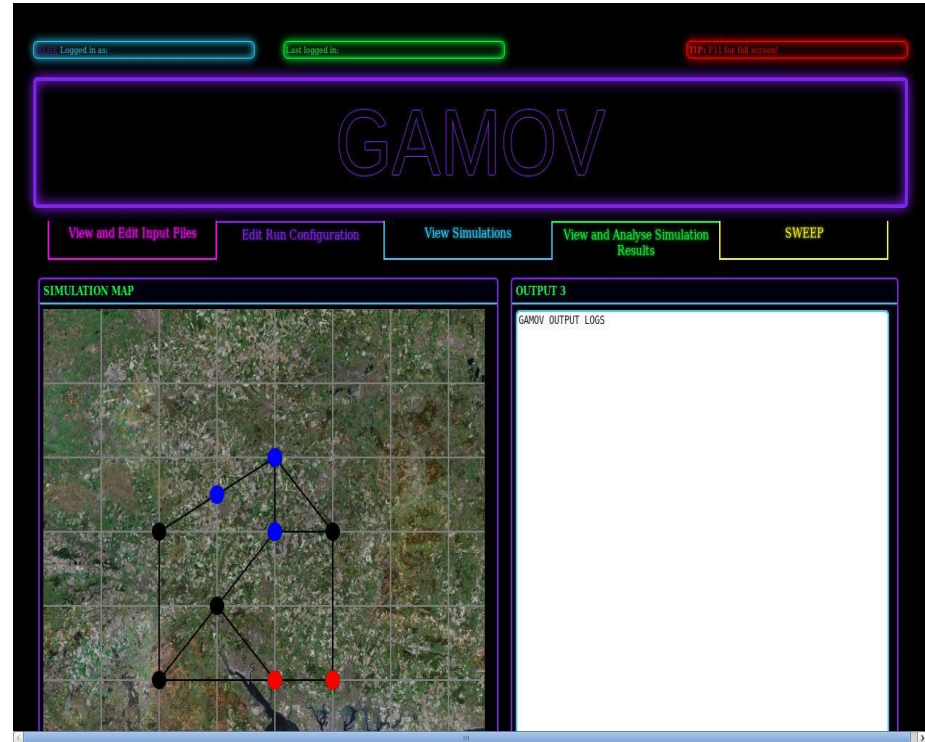
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A new approach to model design

- Modular
 - Following Object Orientated coding
- Flexible
 - Can add or remove modules as requires
 - Can use different levels of fidelity
- Robust
 - Separating data and functionality
- Rapid
 - Can build models in weeks not months/years
- All of which should allow cheaper model development

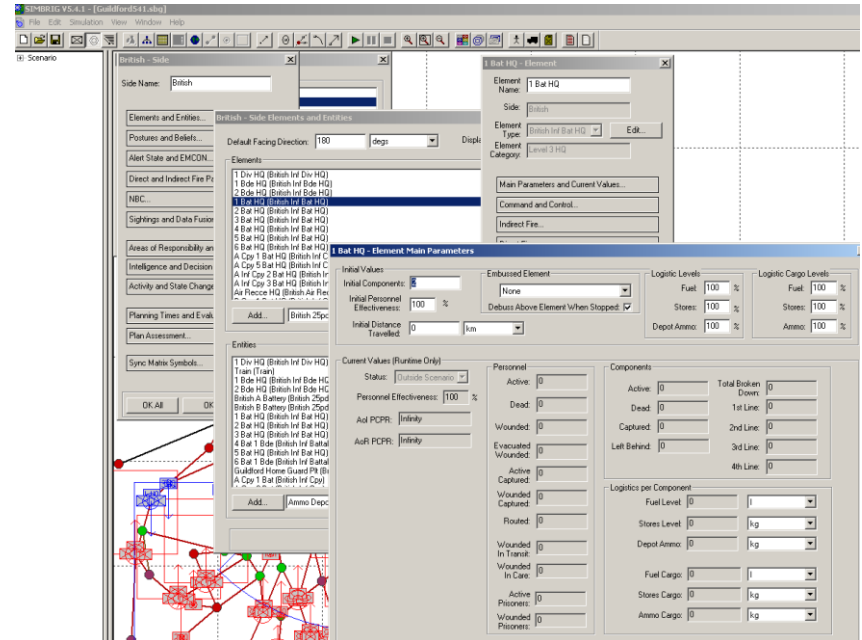
GAMOV

- Generic Aggregator Model Valuator
- Built in Python
 - But can accept compiled modules
- Built around a clock and event scheduler
- Data objects are passed between modules (objects)
 - Mediators operate on data objects
 - Mediators do not need to interact with each other directly
- Web functionality allows Representational State Transfer (REST) style architecture
- Initial operating capability reached



Traditional model running

- Create base case with one course of action
- Long set up time
- Run stochastic variations around that base case
 - Usually based on uncertainty in systems performance
 - Can produce strange results as the script fails
- Small number of variations
 - Driven by the time and difficulty of scripting
 - Often only changing system performance or force elements



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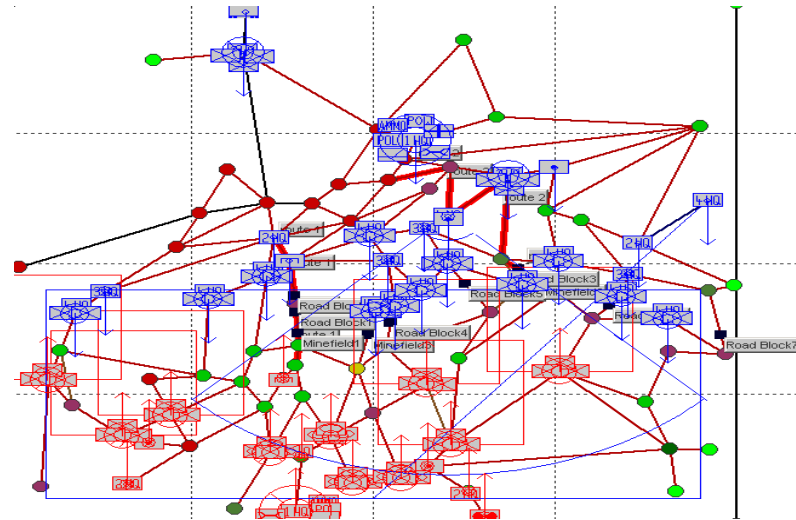
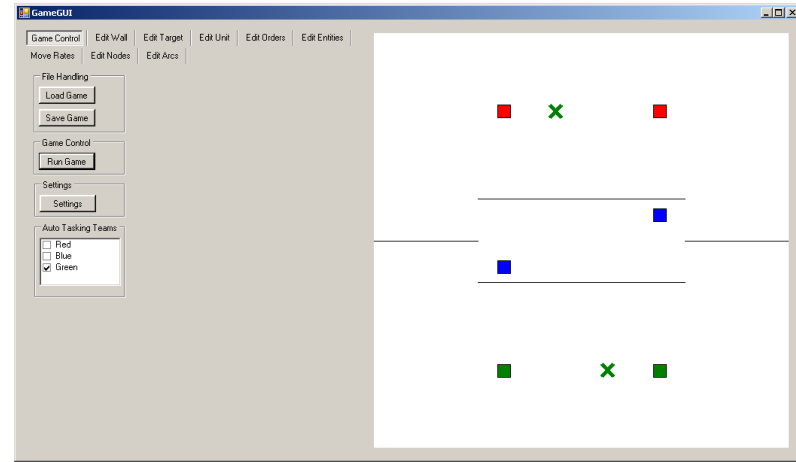
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New Approach to Model running

- Automated decision making
 - Allowing the computer to generate scripts automatically
- Rapid Planner
 - Tests if current course of action is sensible given new information
- Mission Planner
 - Automatically allocates forces in space and time to achieve a given effect
- Initially aiming for “not stupid” decision making
 - Hope to improve this over time

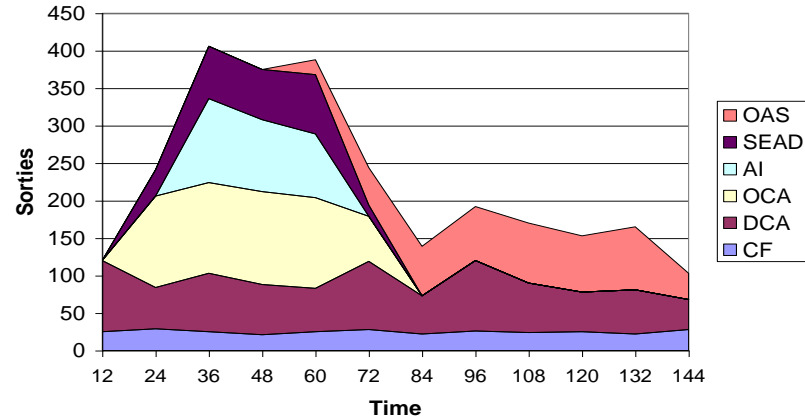
Mission Planner

- Uses mathematical optimisation techniques
 - Genetic Programme and Simulated Annealing
- Key requirement is for plan tester
 - What does a good plan look like
 - Using meta models to speed run time
- Perception based
 - Plans only on what it “knows” about
- Can cope with uncertainty
 - Optimise against a number of potential courses of action
- Test bed built around the SIMBRIG model



Traditional data analysis

- Mean and standard deviations
 - Basic examination of distribution
- Detailed examination of a small number of runs
 - Around mean or particular outliers
- Frequently watching the model run to understand behaviour
- Cause and effect often difficult to separate



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Future Data Analysis

- Use of High Performance Computing and Automated decision making greatly increasing explored solution space
 - Variation in behaviour as well as performance
- Will generate very large very complex data sets
 - Need to understand cause and effect automatically
- Will need to generate new analytical tools to support new models

SWEEP

- Semantic Web Examiner of Emergent Phenomena
 - Designed to identify and interpret emergent behaviours through the production of causation chains
 - Uses Semantic Web technologies to describe relationships between data and concepts
- Will become a homogenous component of the GAMOV toolset
 - Modelling concepts can be described with Semantic Web technologies during construction
- Significant challenges remain in terms of processing data produced by Semantic Web
 - SWEEP exploits HPC and parallel processing to reduce computational requirements

The future

- Using constructs similar to the semantic web
- Semi automate the generation of models from existing modules
- Allow rapid analysis of diverse data sets using “intelligent” agents to spot connections
- Allows storage and reuse of extant data
 - Currently often easier to regenerate data as stored data loses context

Questions

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