



Modeling Multiple Operators Supervising Multiple Unmanned Vehicles

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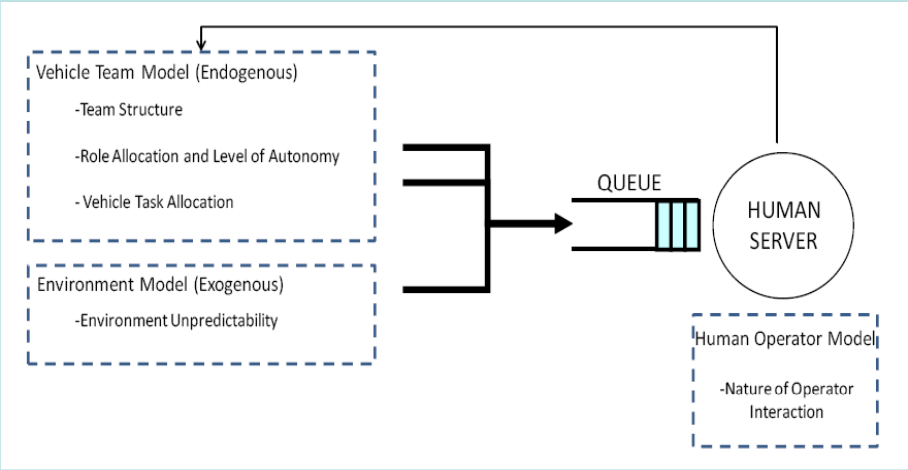
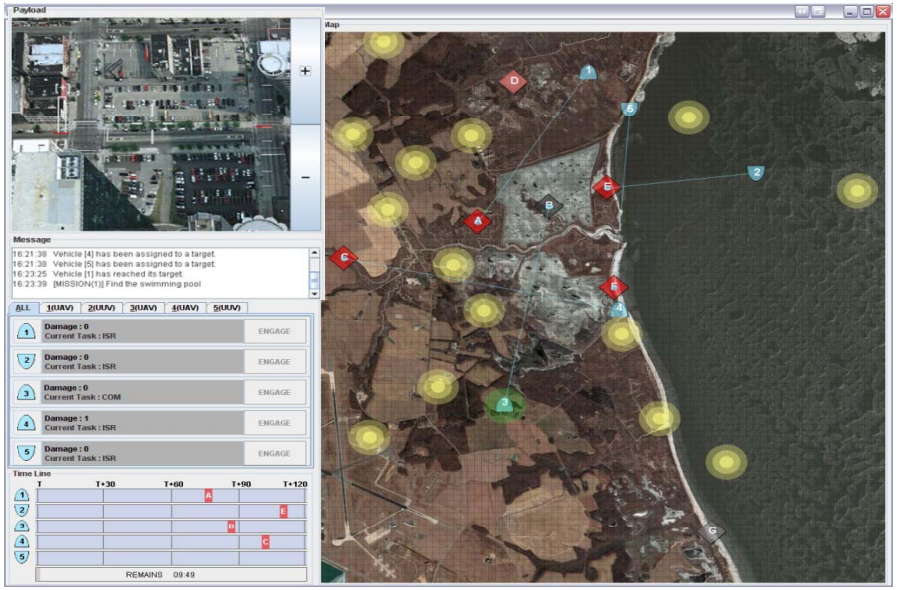
Modeling Multiple Operators Controlling Multiple UVs

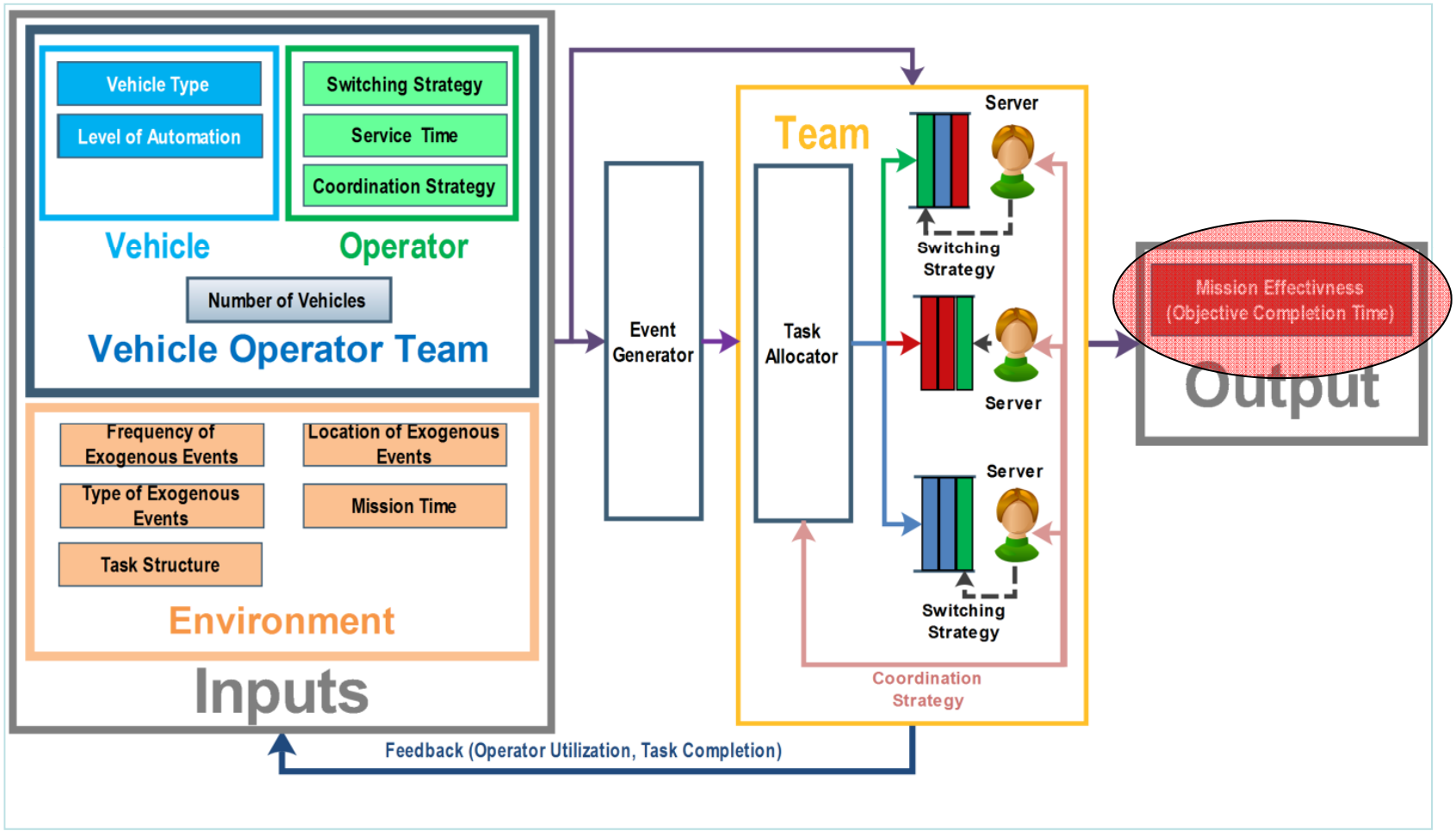
- Phase I
  - Adapt a single operator-multiple UV discrete event simulation model to the multiple operator case
  - Assumption is that the arrival of exogenous events are detectable, i.e., we know when targets “arrive” and they are always detected





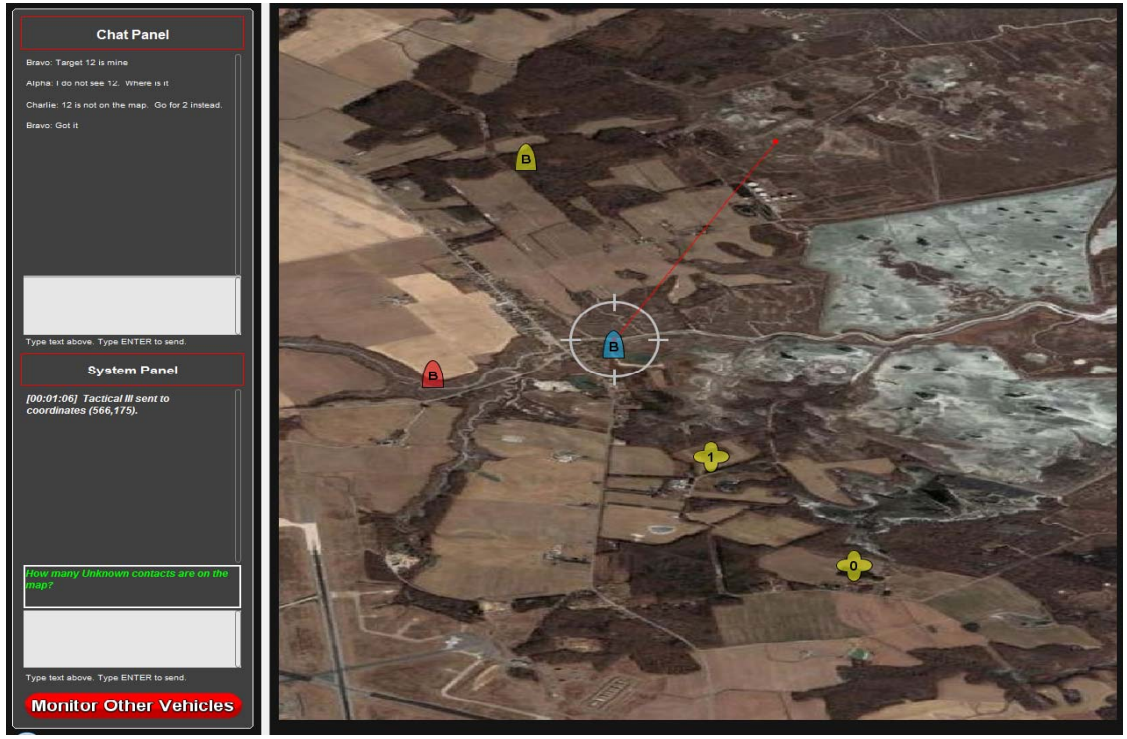
MO-MUVDES

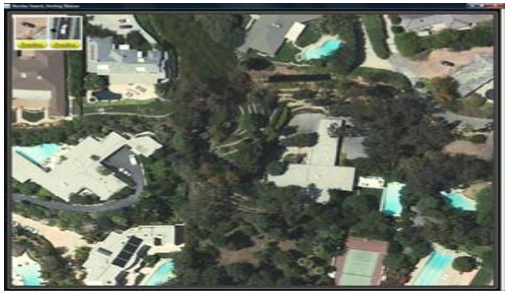
Multiple Operator-Multiple Unmanned Vehicle Discrete Event Simulation



MO-MUVDES Test Bed

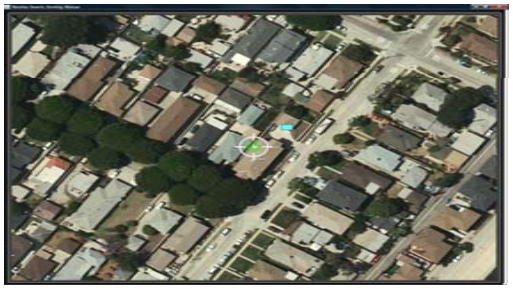
- Assumption: At least 1 team member detects target arrival





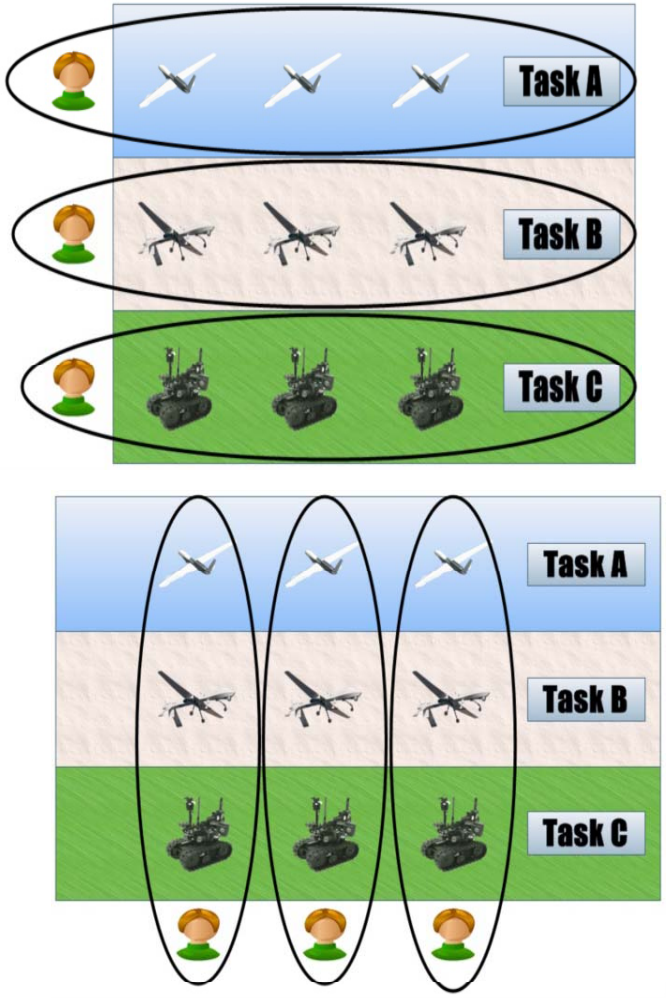
Visual ID Task

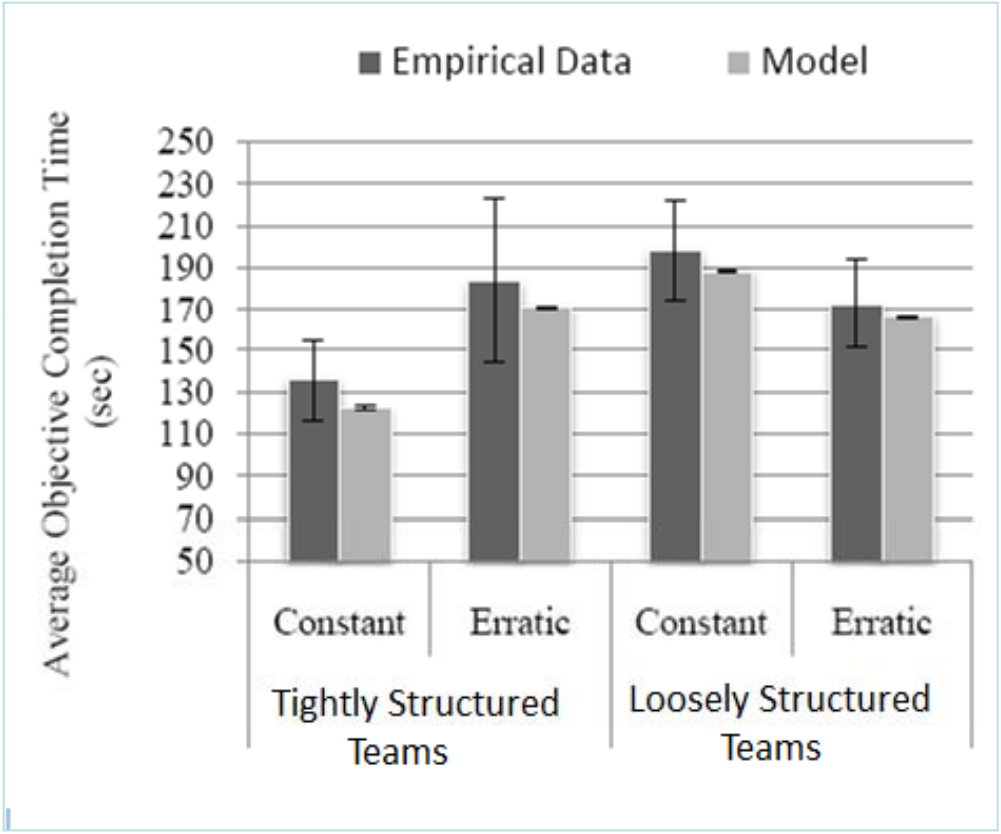
Missile Firing Task



Aid Drop Task

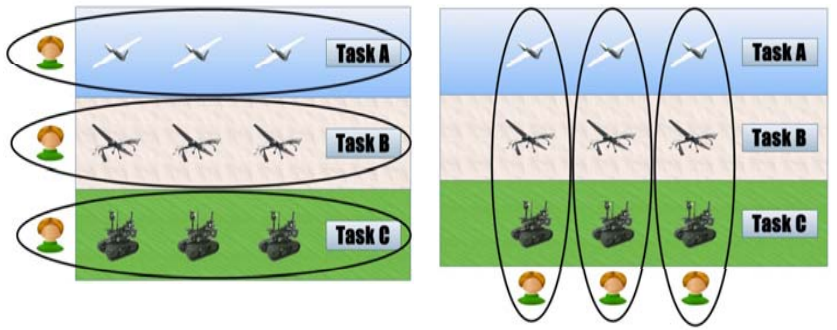
Experiment #1 & Results





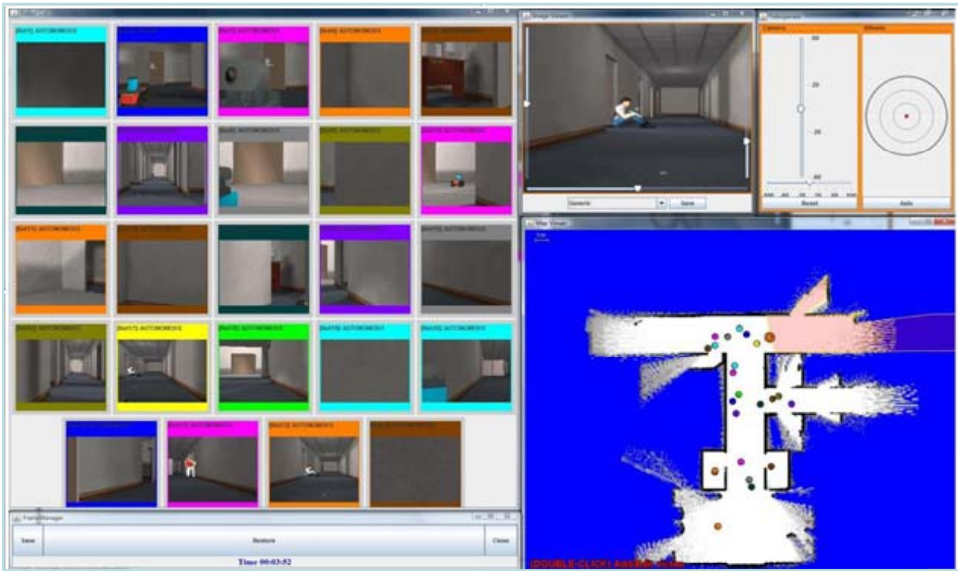
Meta-analysis of Pitt & MIT studies

- What can we say about team structure?
  - Call center (loosely structured) vs. Individual Assignment (tightly structured)
- In both studies, the tightly structured teams performed better
  - Pitt: For *region explored* but not *victims found* (team performance the same)
  - MIT: Except in the erratic arrival case, where loosely structured was better
- Deserves further study since erratic arrivals can be more externally valid in some settings.



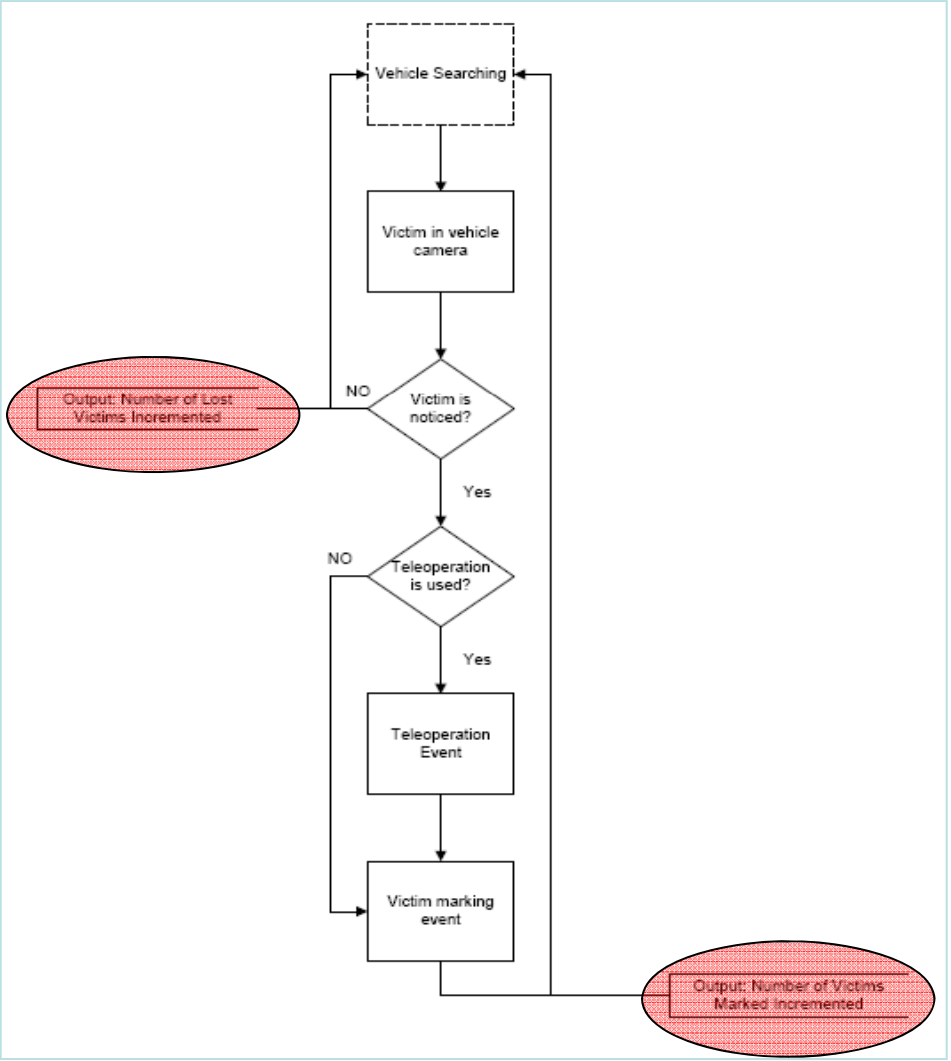
Uncertainty in the Environment

- Phase 2
  - Adapt model for the case that events “arrive”, but often go undetected
  - A more appropriate model for searching for possible victims/targets with no observable arrival
  - Teamed with Pitt
  - Two operators either performing Batch control (12 robots per operator) vs. Queuing control (both operators can service all 24 robots)

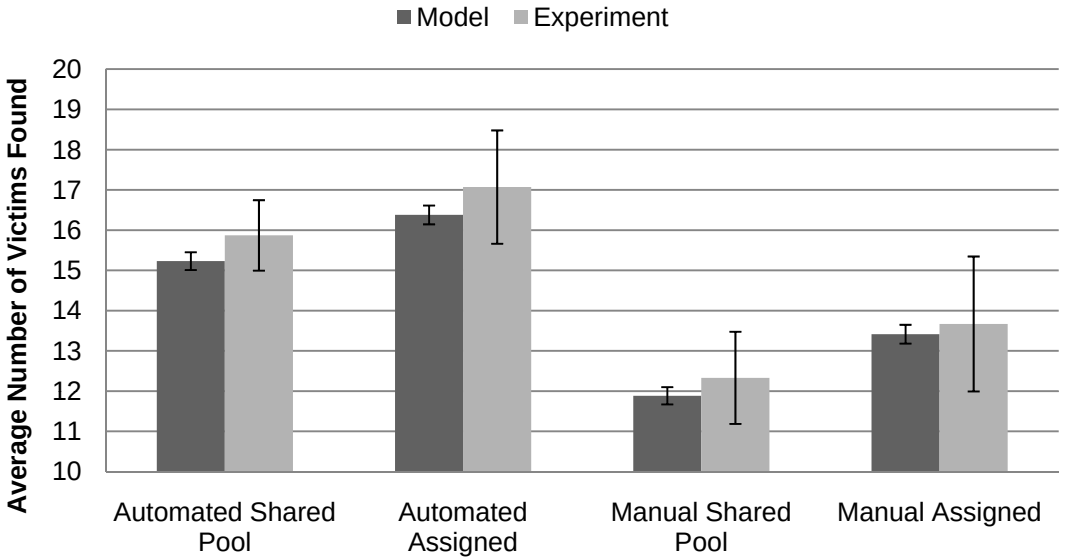


Model Modifications

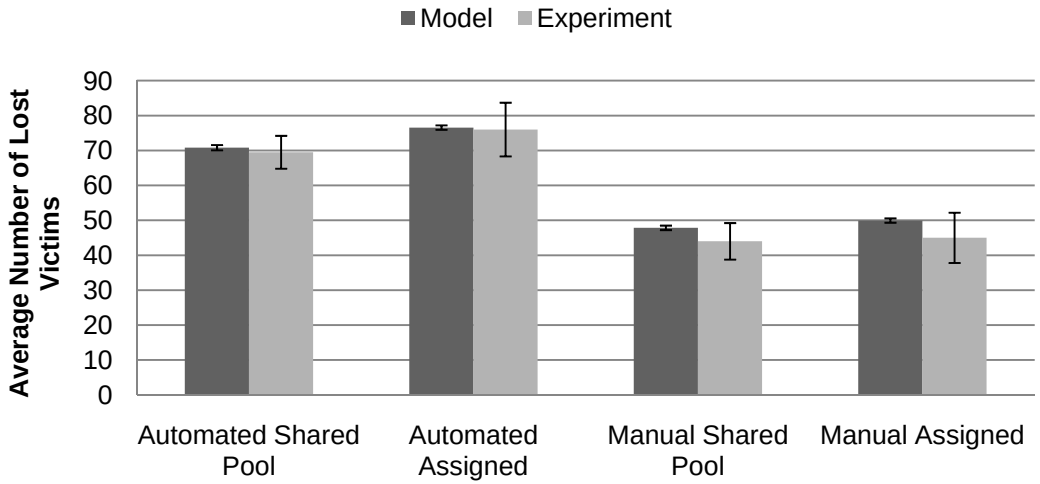
- Inclusion of teleoperation mode
- Inclusion of variable search strategies
  - Manual vs. Automation
- Distribution for Victim in Camera (VIC) events was a problem
  - Monte Carlo estimations based on observing 24 camera feeds for four 15 minute experiments used to develop VIC distribution.
  - Signal detection rates also had to be estimated



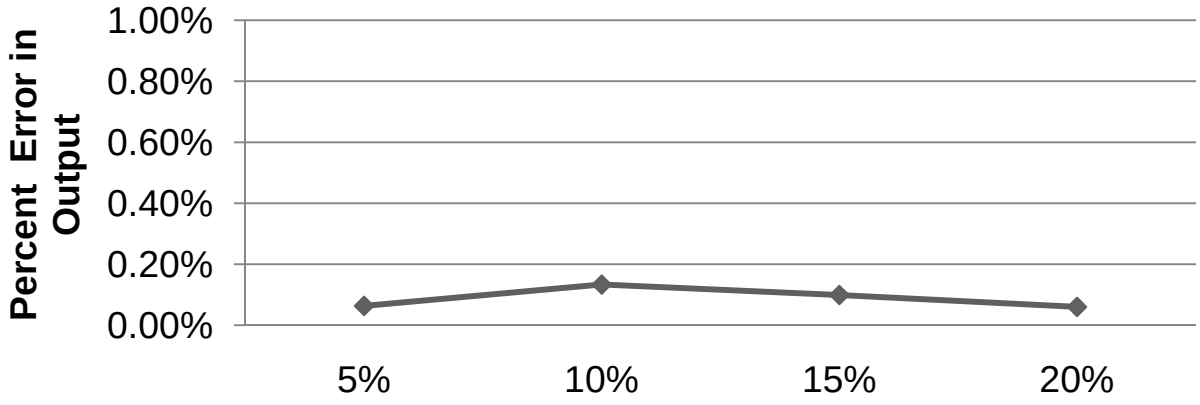
Results



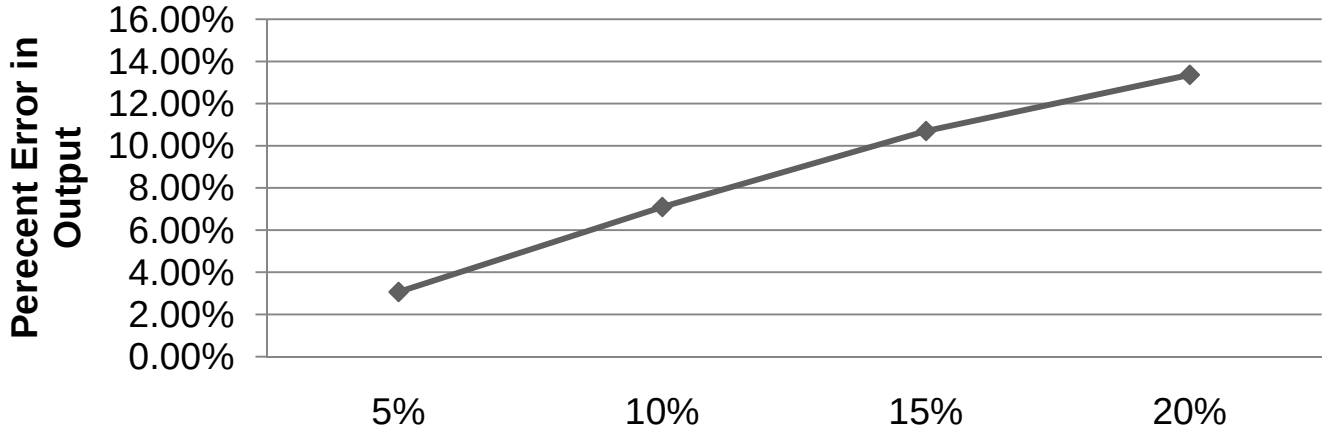
- Still no significant difference between team structures



Model Sensitivity



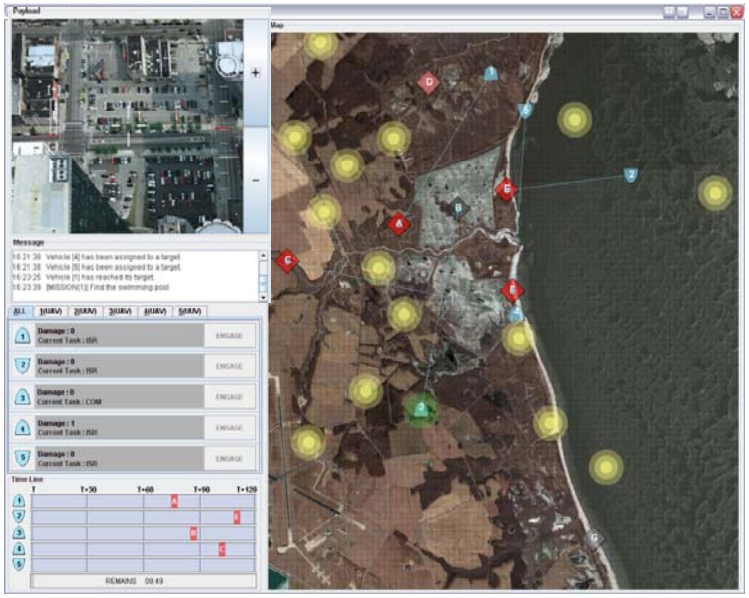
Percent Error in Mean Service Times for VIC events.

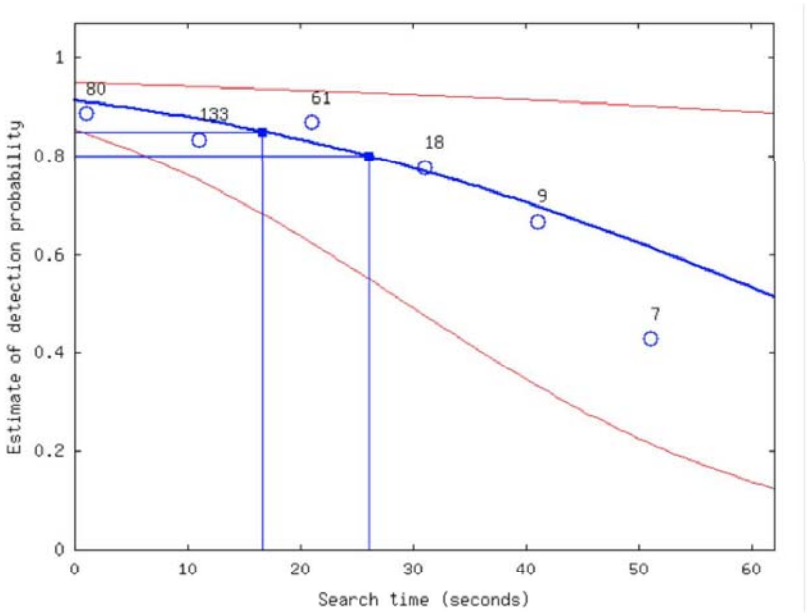


Percent Error in Mean Event Arrival Times for VIC events.

Experiment in Progress

- Replicate previous experiment but w/ a few changes
  - Joint effort with Pitt
  - Better VIC estimates/data logging
    - Could become an independent variable for future work
  - Communication modeling
  - Automated cueing based on related AFRL research effort





Conclusion

- Ultimate goal is to determine how to use these models to improve system performance
  - Cueing/switching strategies & varying team structures
  - Informed vs. uninformed searching
  - Extension beyond 2-3 people
- Deliverables
  - Multi-operator UV control test bed
  - McDonald, T., “A Discrete Event Simulation Model For Unstructured Supervisory Control Of Unmanned Vehicles,” MIT, 2010.
  - Mekdeci, B., & Cummings, M. L. Modeling Multiple Human Operators in the Supervisory Control of Heterogeneous Unmanned Vehicles, PerMIS,2009.