

Resilience Modeling in Complex Engineered Systems with Human-Machine Interactions

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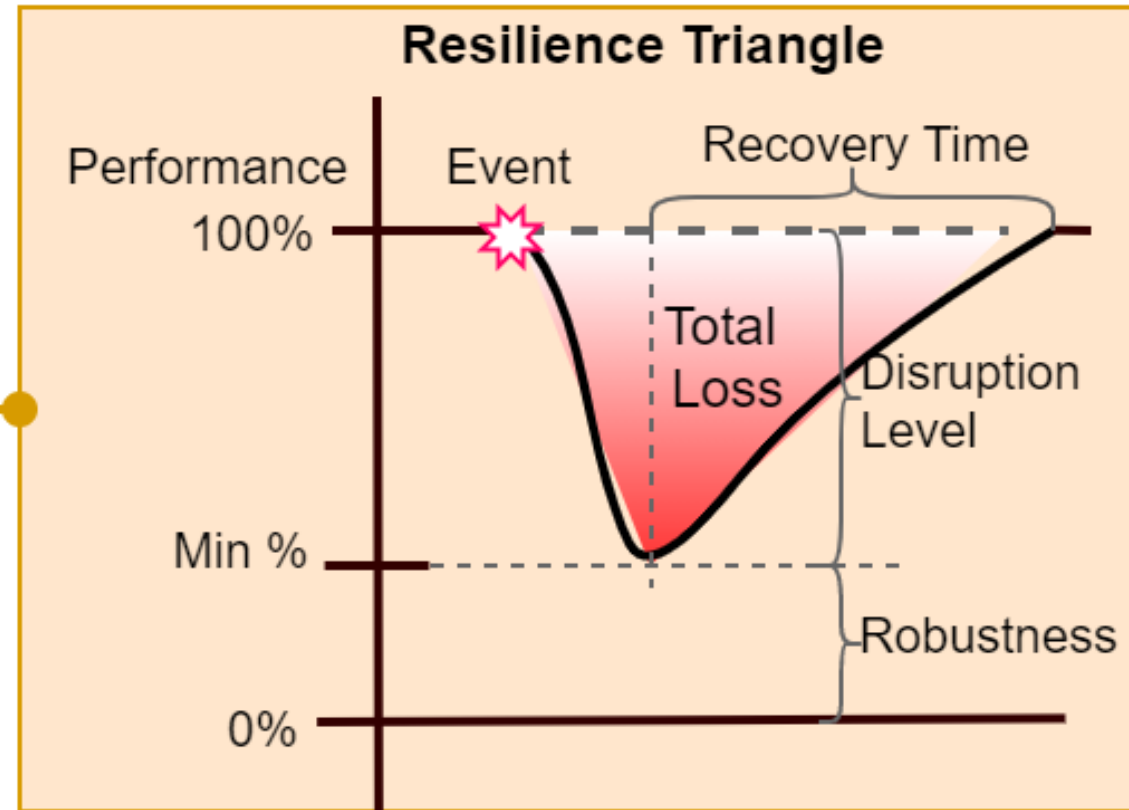
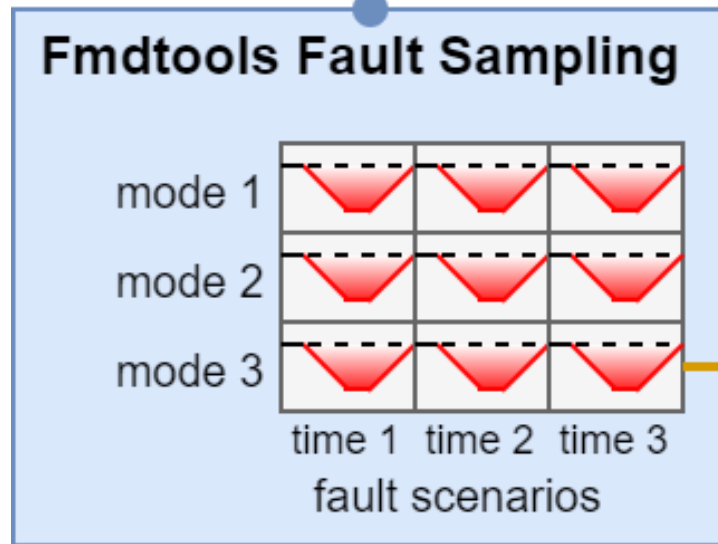
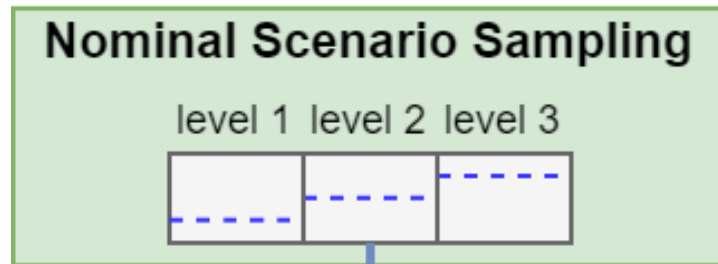
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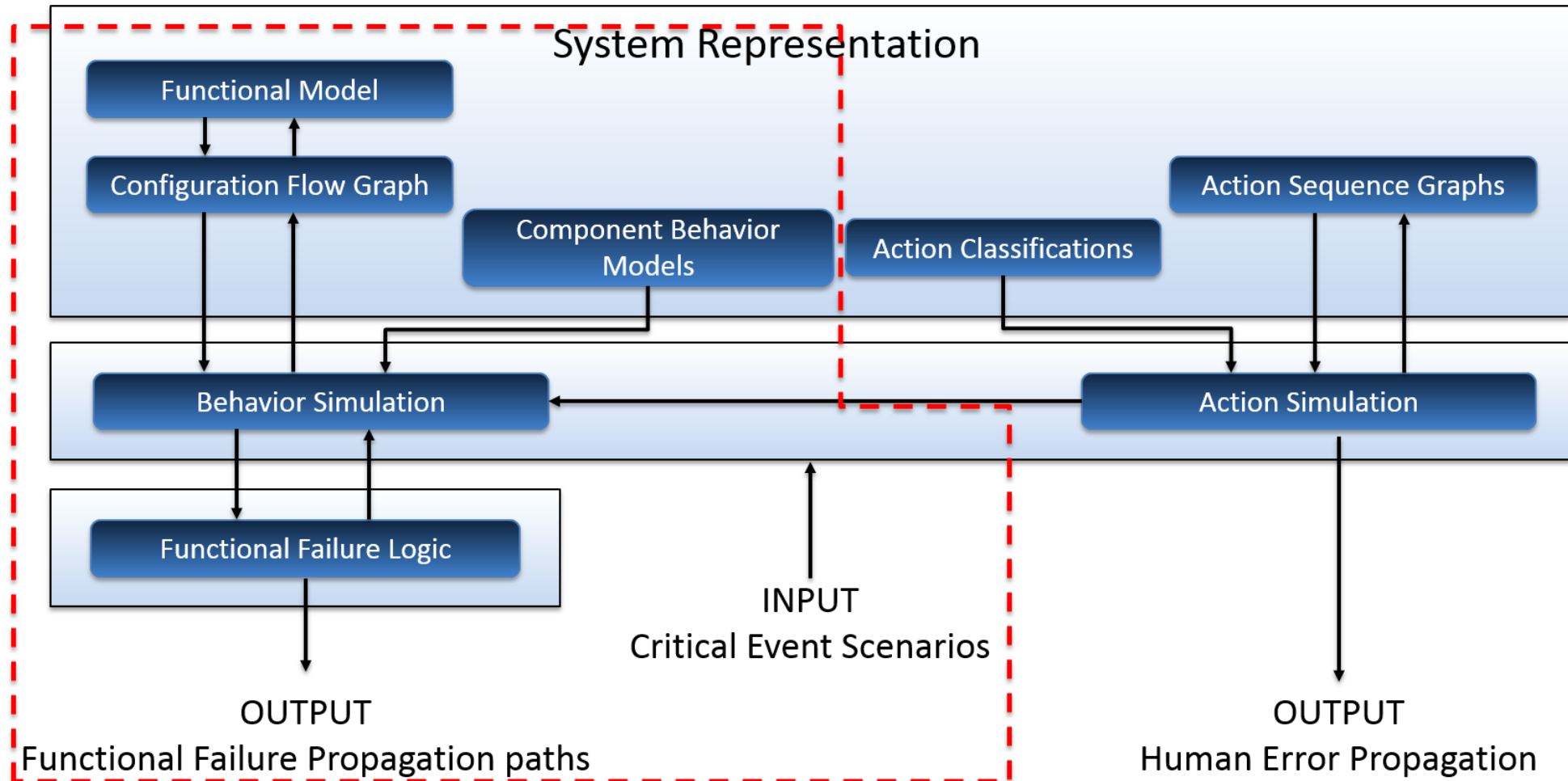
Motivation

- Failures – results of complex scenarios interacting
- Resiliency – “failures and unexpected events will happen, and when they occur, complex engineered systems should be able to operate within acceptable bounds and recover reasonably”
- Human and resilience
- Existing method study resilience in isolation

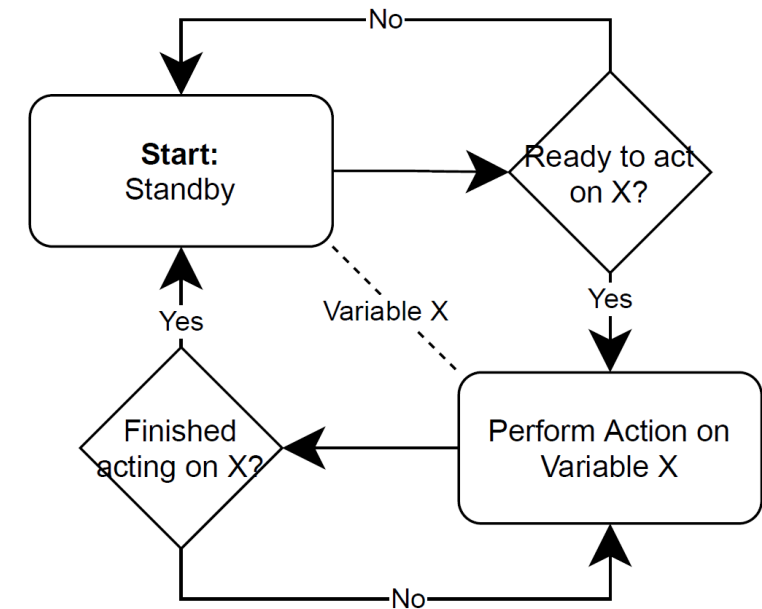
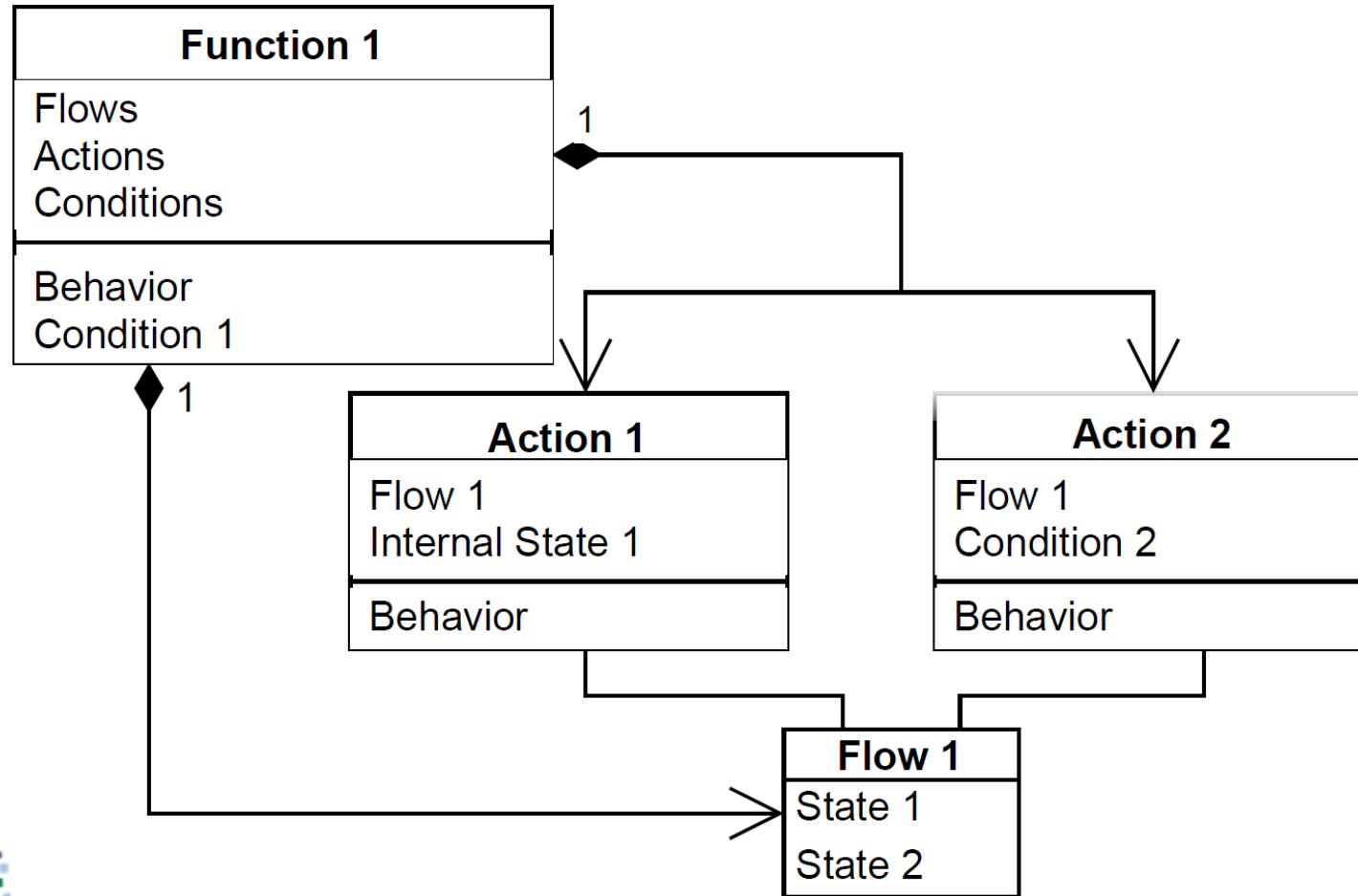
Previous Work - fmdtools



Prior Work: HEFFR Framework

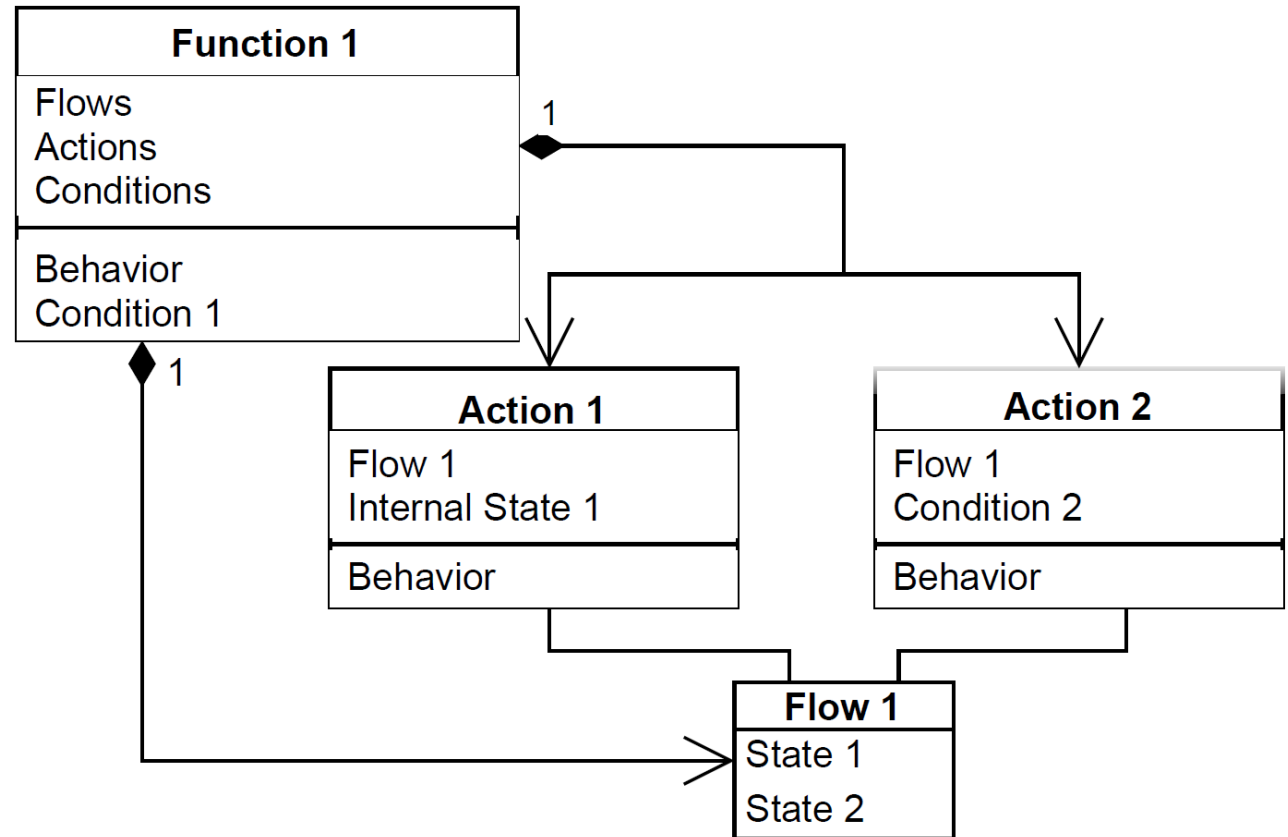


Integrating HEFFR with fmdtools



Performance Shaping Factors

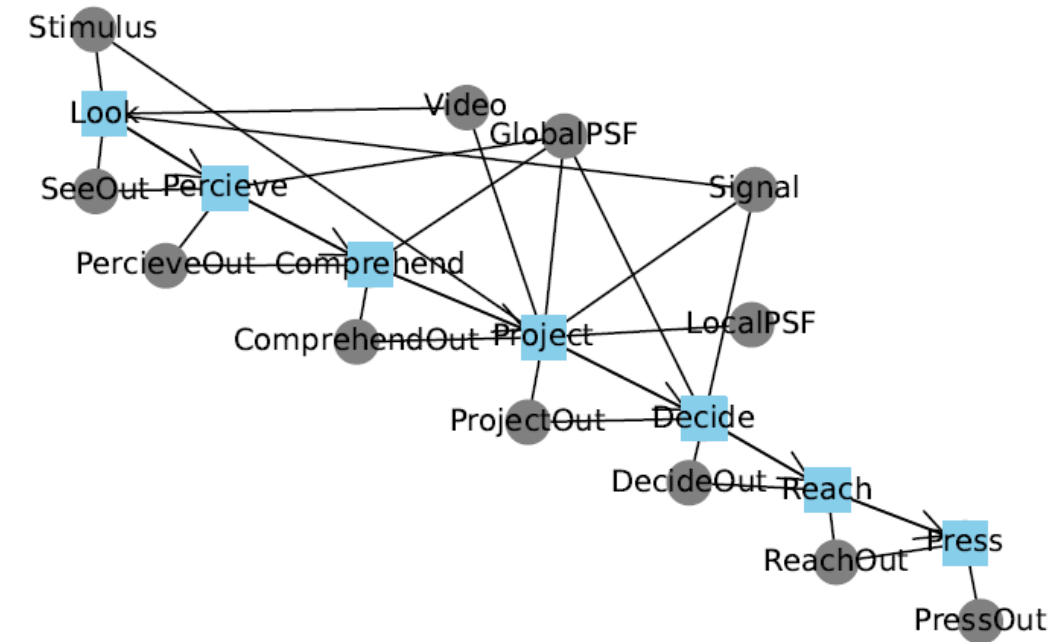
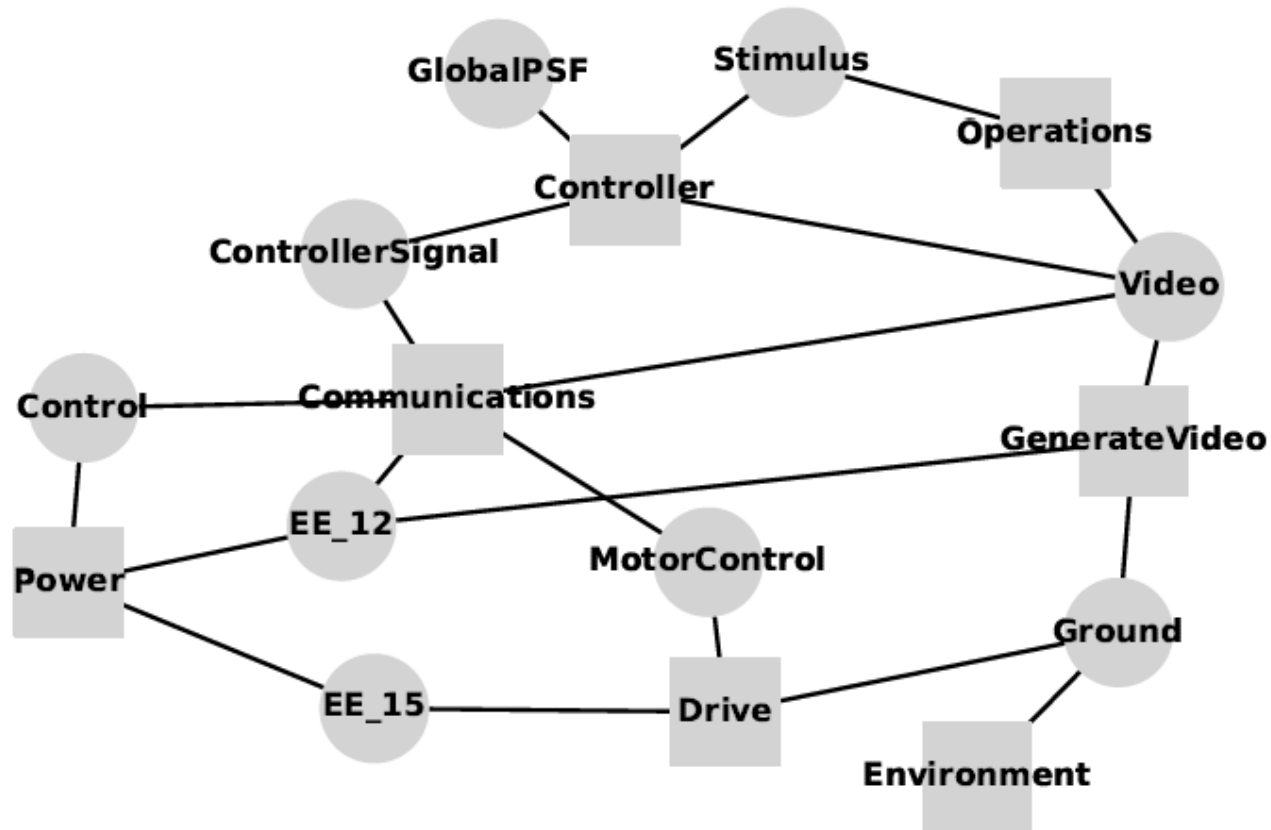
- Global performance shaping factors
- Local performance shaping factors



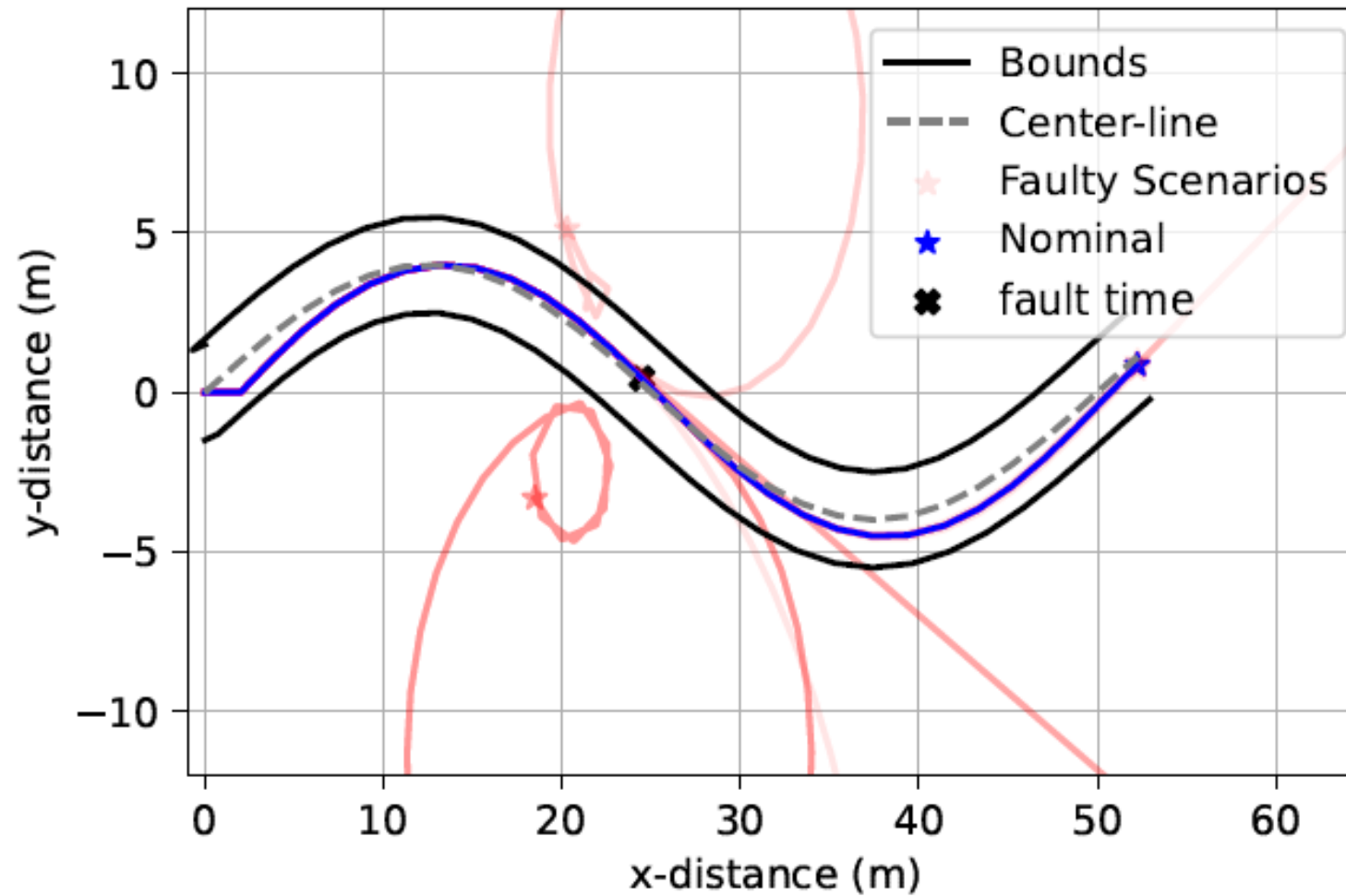
Creating Action Sequence Graphs

- Cognitive Processing models
- Multiple Operators
- Team Dynamics
- Systems of Systems

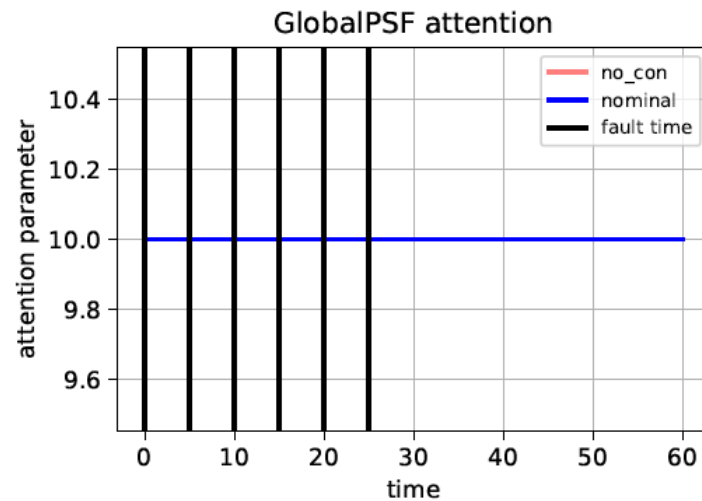
Demonstration



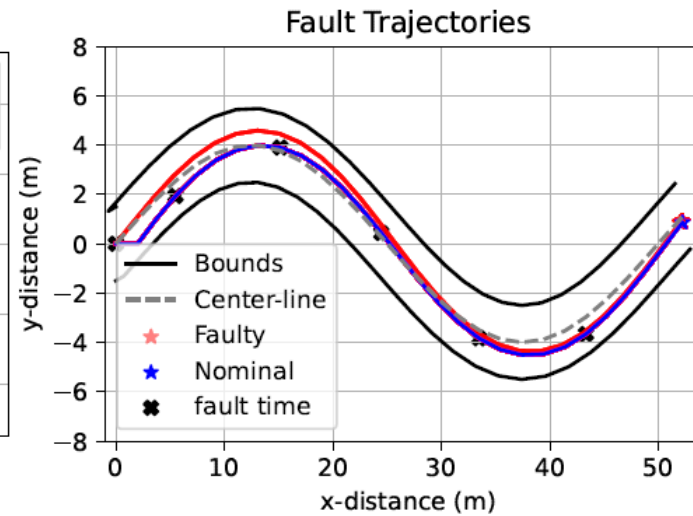
Results



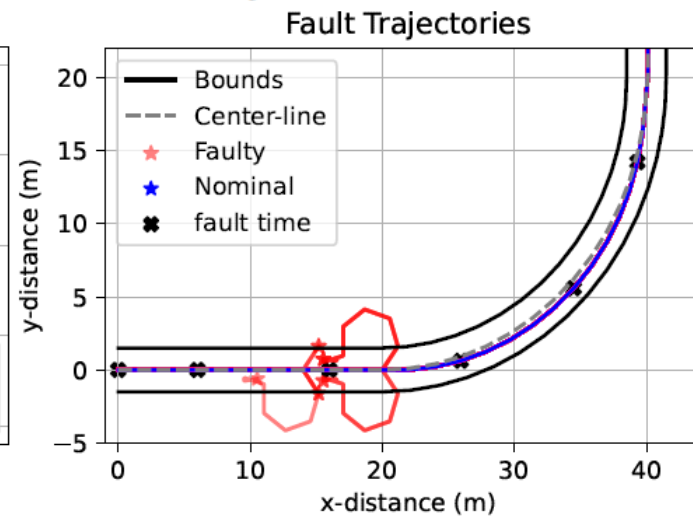
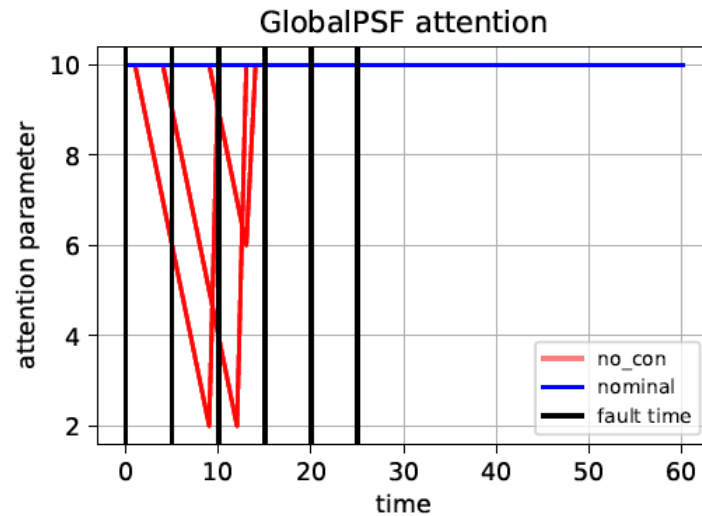
Results



(a) Attention (Sine Curve)



(b) Trajectories (Sine Curve)



Discussion

- Performance shaping factors modeling
- Representation of cognitive models
- Validate resilience (and human factors) related requirements
- Dependency on scenarios modeled
- Uncertainties

Takeaways

- Human-machine interaction-related failures modeling (including continuous-time dynamic simulations)
- Effects of detrimental performance shaping factors
- Human-system and team-system interactions modeling in systems of systems (using object-oriented simulation)

Questions?

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researchgate.net/profile/Daniel-Hulse-4

Resilience Analysis and Design Project

website:

ti.arc.nasa.gov/tech/rse/research/rad/

Fmdtools Simulation Package

repo:

documentation:

github.com/nasa/fmdtools

nasa.github.io/fmdtools/



Workflow

