



# SinhaRoy\_TechPresentation\_202

July 2024

*Changing the World's Energy Future*

Sonali Sinha Roy, Maria Eduarda Montezzo Coelho



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**July 2024**

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**Manager:** Peter A. Suyderhoud

**Organization:** B711 (Model Based Design)

## The Digital Engineering Vision for DOME: Facilitating Design, Deployment, and Operations

Battelle Energy Alliance manages INL for the  
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Idaho National Laboratory

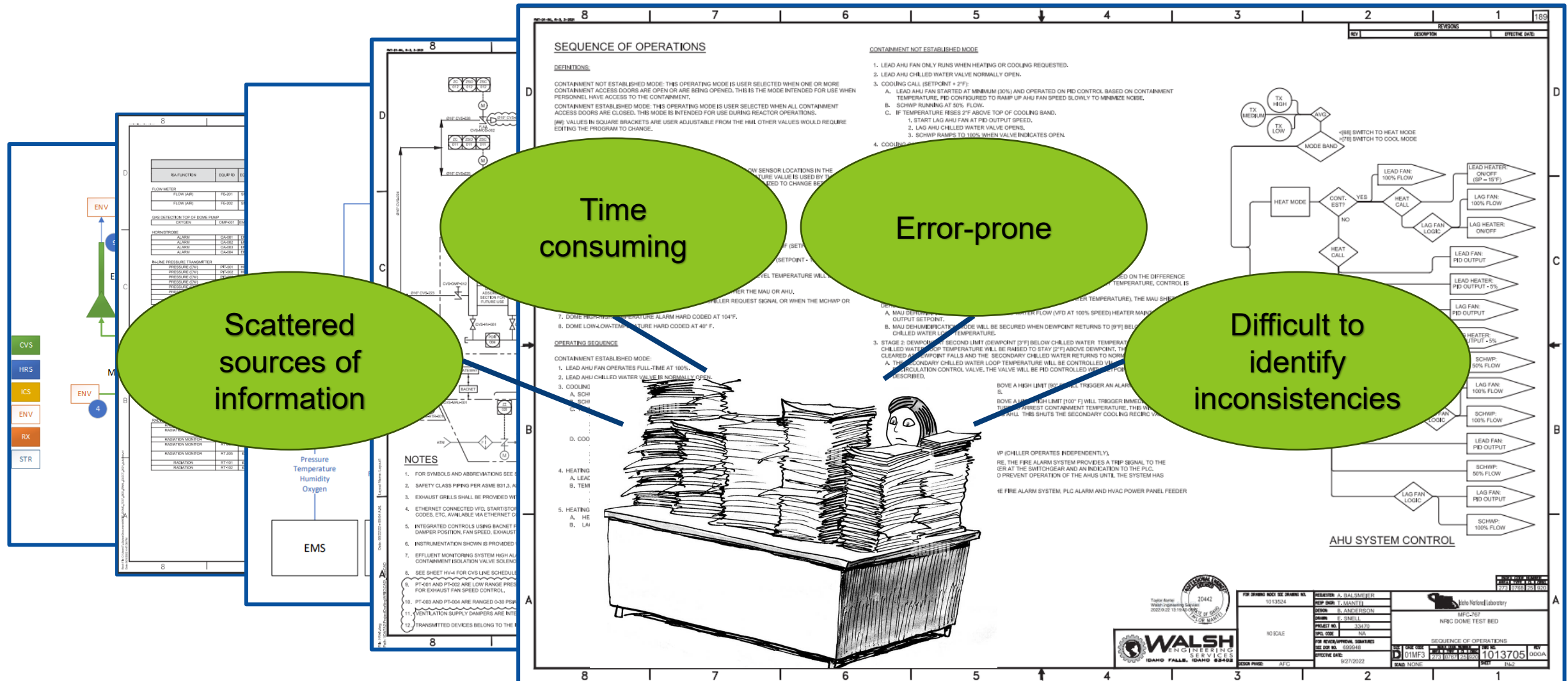
# DOME: Demonstration of Microreactor Experiments

- Microreactor testing initiative sponsored by the DOE's National Reactor Innovation Center (NRIC).
- Repurposes the decommissioned Experimental Breeder Reactor (EBR)-II at INL's Materials and Fuels Complex (MFC) as a Hazard Category 2 test bed for a series of commercial microreactor experiments.
- Complex system with several interacting elements, including microreactor (up to 20 MWth), radioactive confinement, temperature and pressure regulation, and ventilation system.





# Traditional Systems Engineering Approach



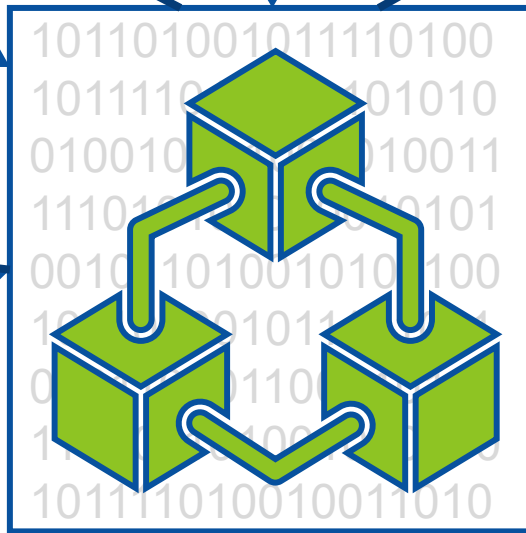
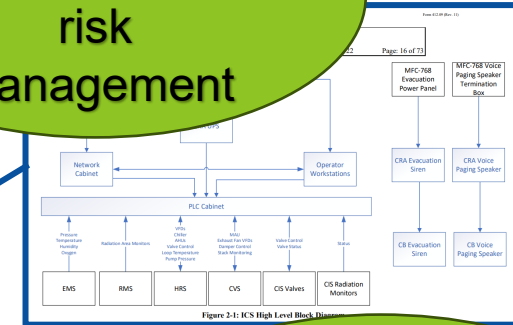
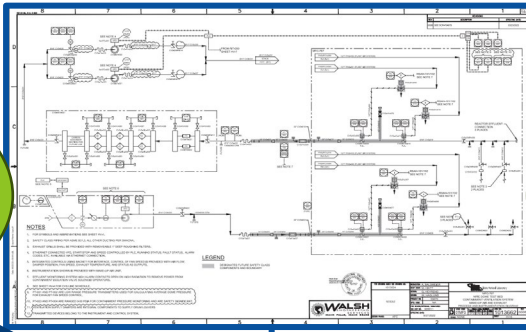
# Model-based Systems Engineering

Improved  
communication  
& collaboration

Better  
requirements &  
risk  
management

Data is  
contained  
within the  
model

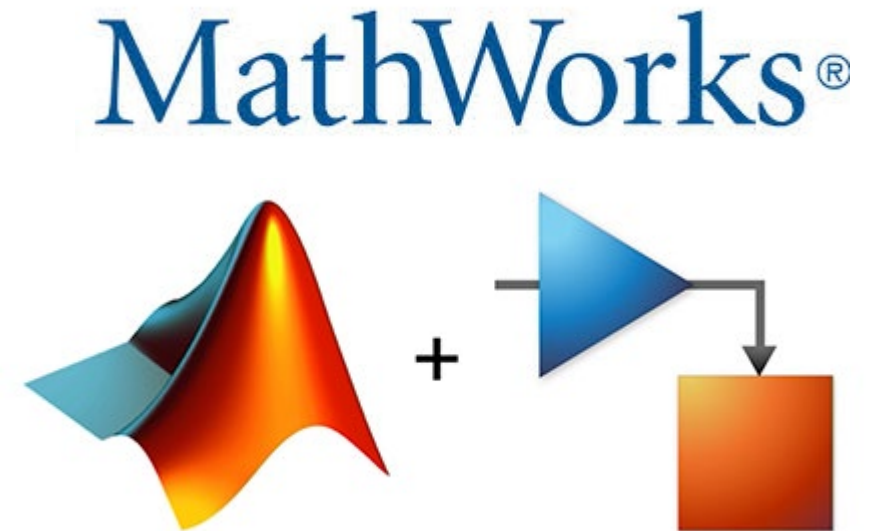
Increased  
efficiency due  
to early fault  
detection



**DIGITAL MODEL**

# MBSE Tools

- Lots of options!
  - **Languages:** Unified Modeling Language (UML), Systems Modeling Language (SysML), Lifecycle Modeling Language (LML), Arcadia, etc.
  - **Tools:** MagicDraw (Dassault Systèmes), Innoslate (SPEC Innovations), Capella, Rhapsody (IBM), GENESYS (Vitech), etc.
- We selected the MathWorks suite, i.e., **MATLAB & Simulink**.
  - Multi-faceted capability.
  - Easily programmable.
  - Automatic code generation for graphical elements.
  - Convenient to interface with external tools.

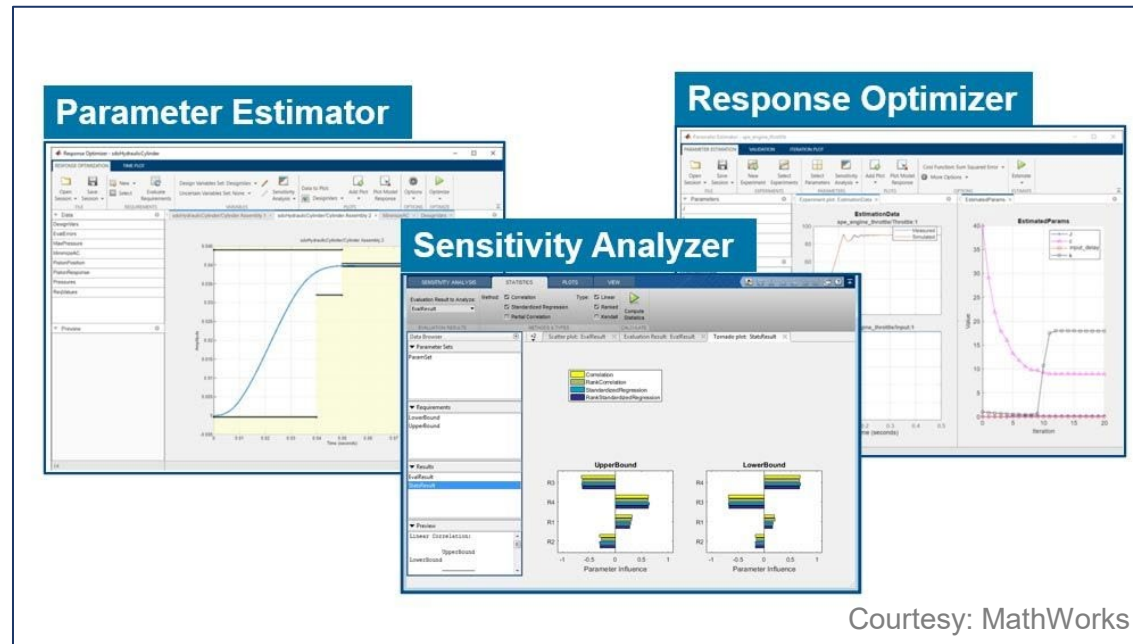


**MATLAB & Simulink**

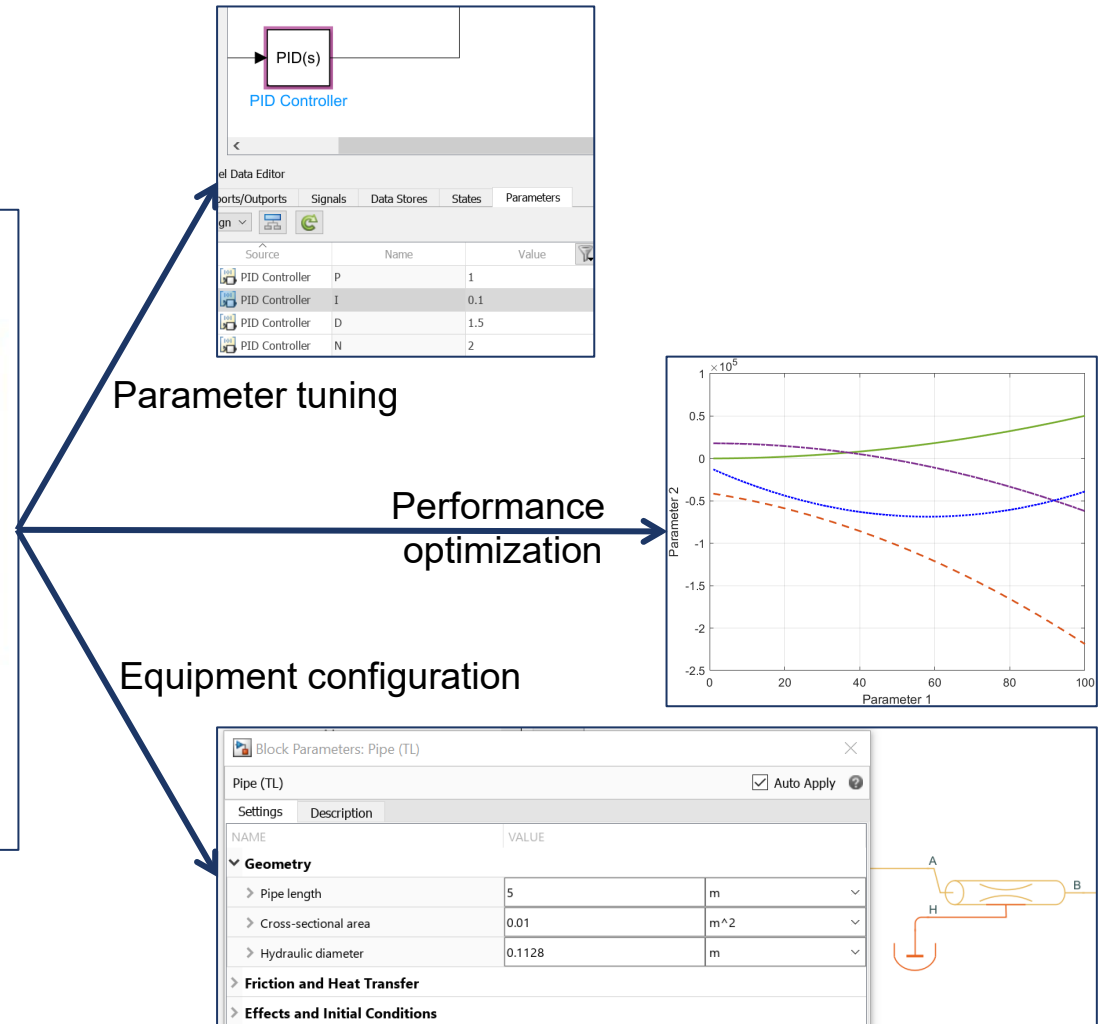




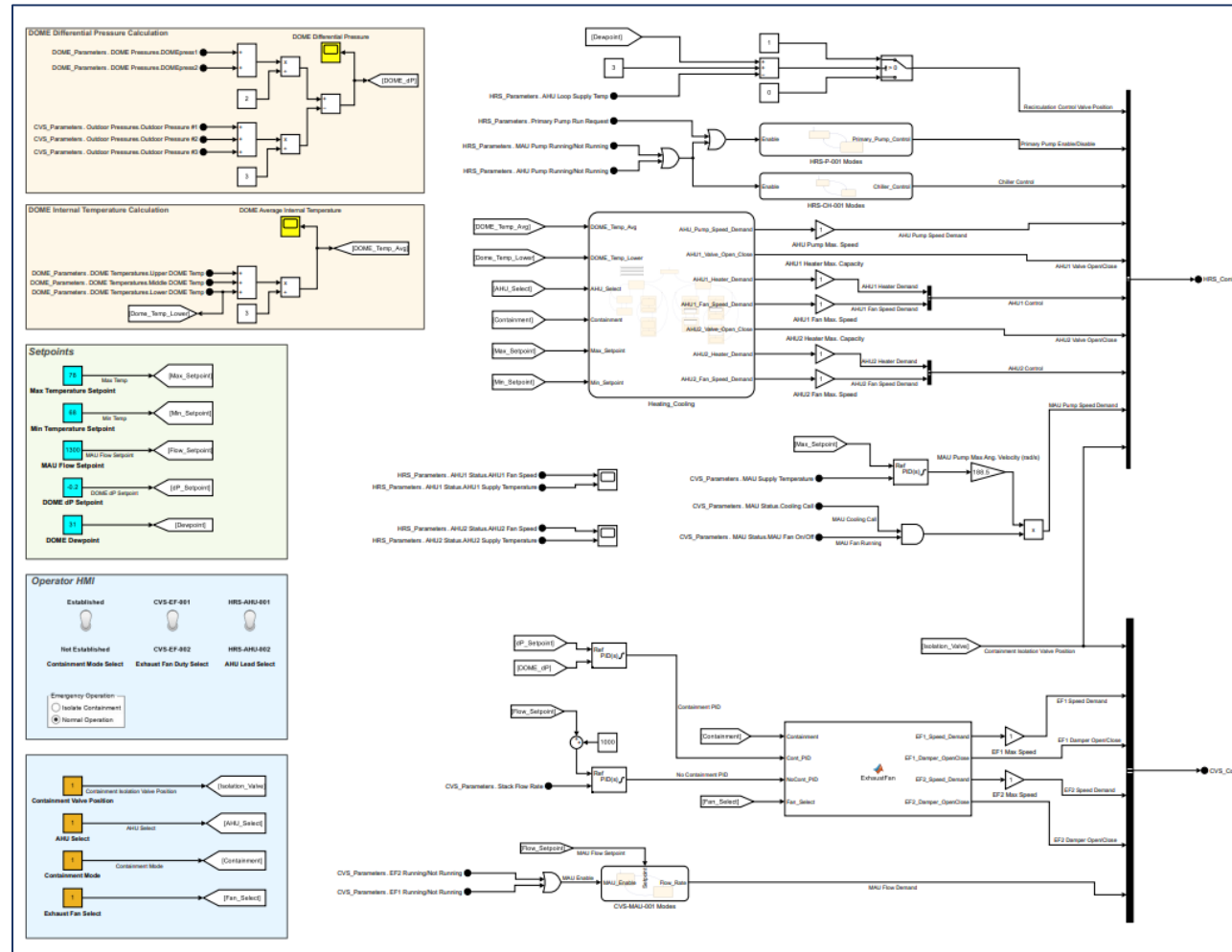
# Application: Design Optimization



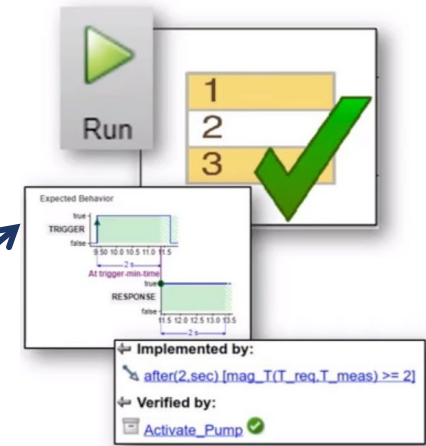
Courtesy: MathWorks



# Application: Facility Simulator / Emulator

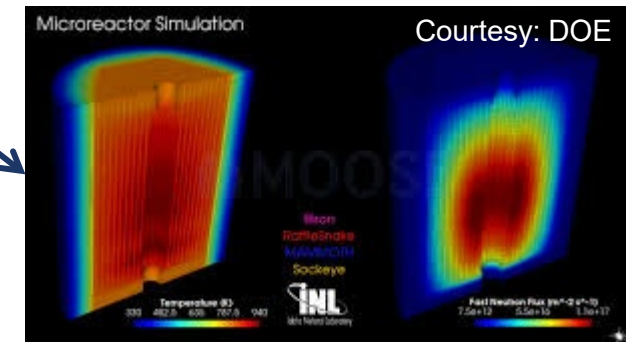


Testing and  
evaluation



Courtesy: MathWorks

Interfacing with  
high-fidelity  
multi-physics  
models



# Application: Digital Twin



Real-time sensor data



Facility monitoring & operator training

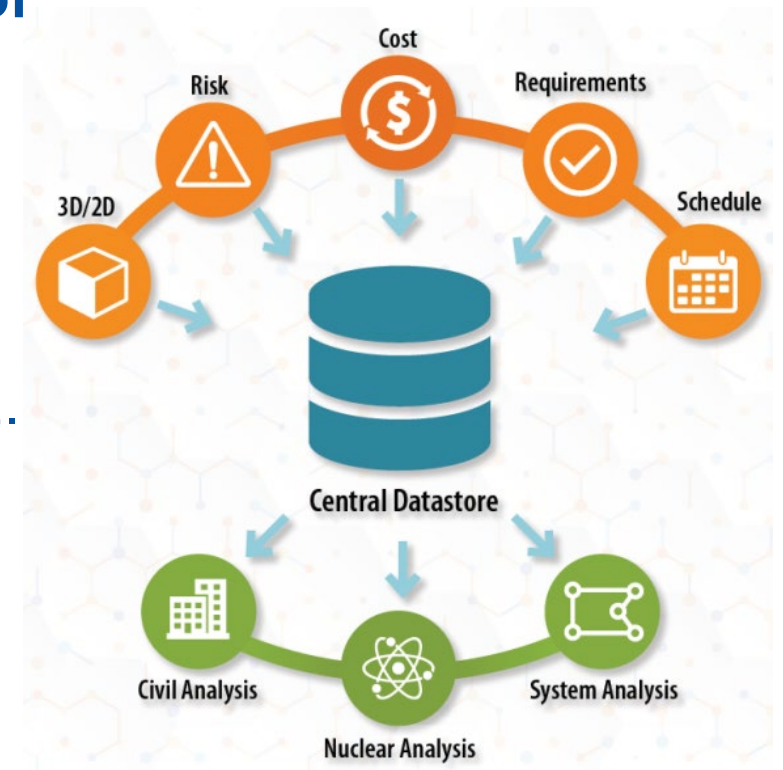


Predictive analysis & virtual testing



# Conclusion

- Digital engineering (DE) can lead to the **optimization of the engineering design process** through a shift from traditional paper-based methods to a **data-driven approach** using industry-leading **modeling and simulation techniques**.
- The goal is to successfully implement DE for the **end-to-end engineering lifecycle management** for DOME.
  - Proof of concept.
  - Learning opportunity.
  - Opens up possibilities for future nuclear reactor projects, including nuclear power plants.
  - Could be applied to other types of energy systems.







# Idaho National Laboratory

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