Human Representation Taxonomy for Model-Based Systems Engineering

Michael E. Miller, PhD
Professor of Systems Engineering
Air Force Institute of Technology

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U.S. DOD Digital Engineering Strategy (2018)

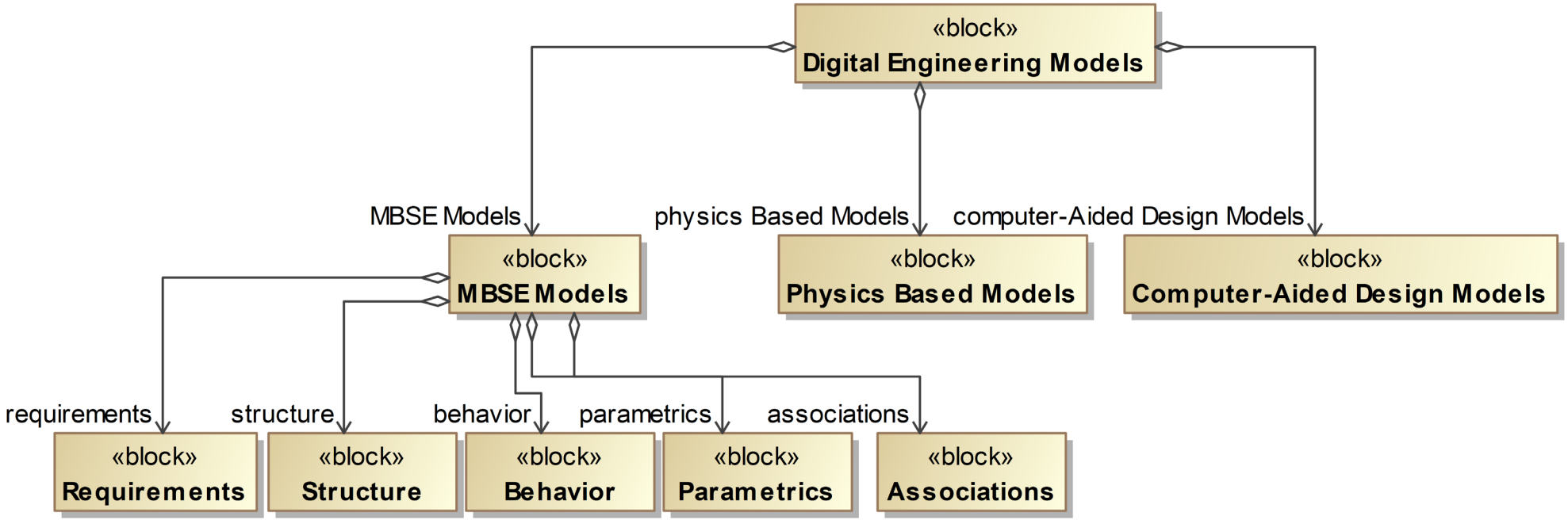
- "Enable the use of models throughout the lifecycle to digitally represent the system of interest (i.e., system of systems, systems, process, equipment, products, parts) in the virtual environment"

- Expected Benefits:
  - Informed decision making/increased transparency
  - Enhanced communication
  - Increased understanding for greater flexibility/adaptability in design
  - Increased confidence that the capability will perform as expected
  - Increased efficiency in engineering and acquisition practices

Figure 4: Examples of Models Connected via the Authoritative Source of Truth

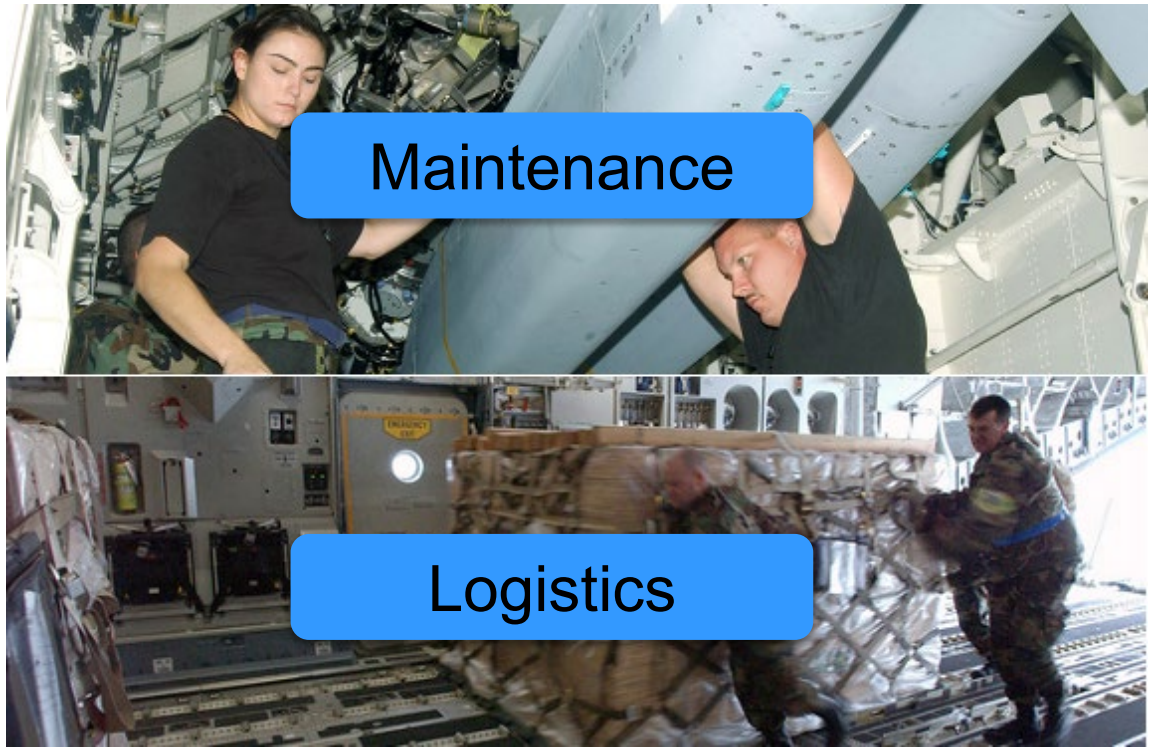
Model Based Systems Engineering

- Important Element of Digital Engineering
- Provides Description of Simulation
- Facilitates Analysis of Systems of Systems, Systems, Components, etc.



Why Model Humans in DOD Systems?

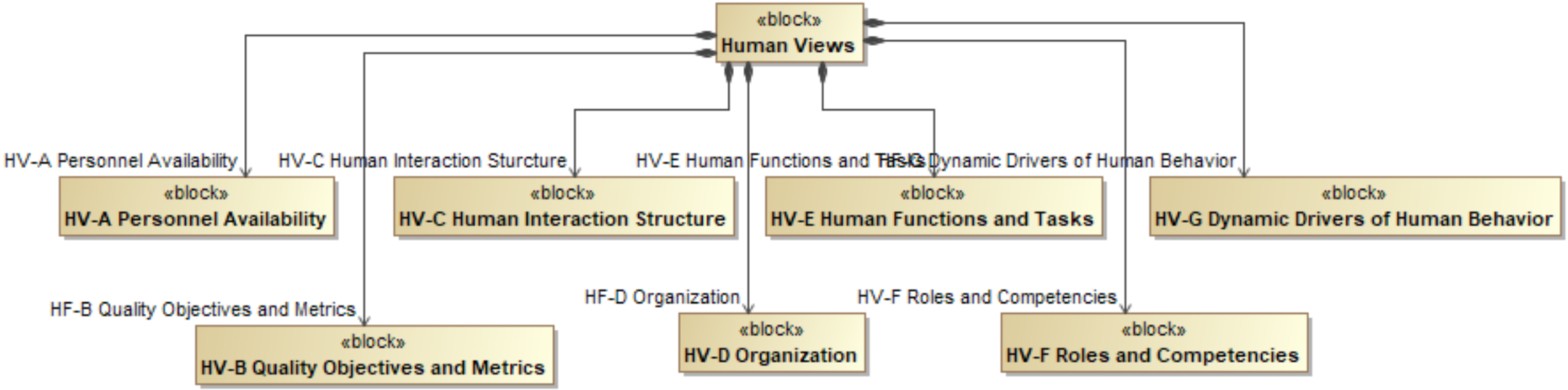
- Humans Play a Tremendous Role in DoD Systems



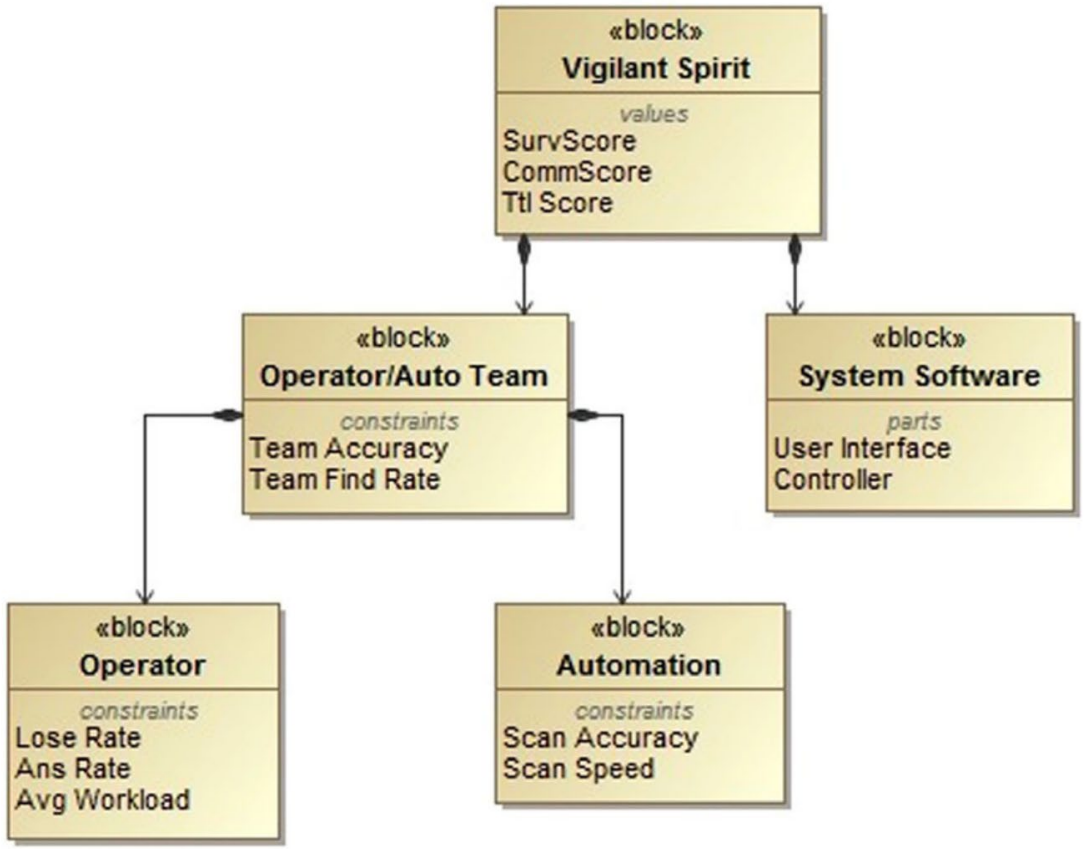
DoD Instruction 5000.95: Human Systems Integration in Defense Acquisition

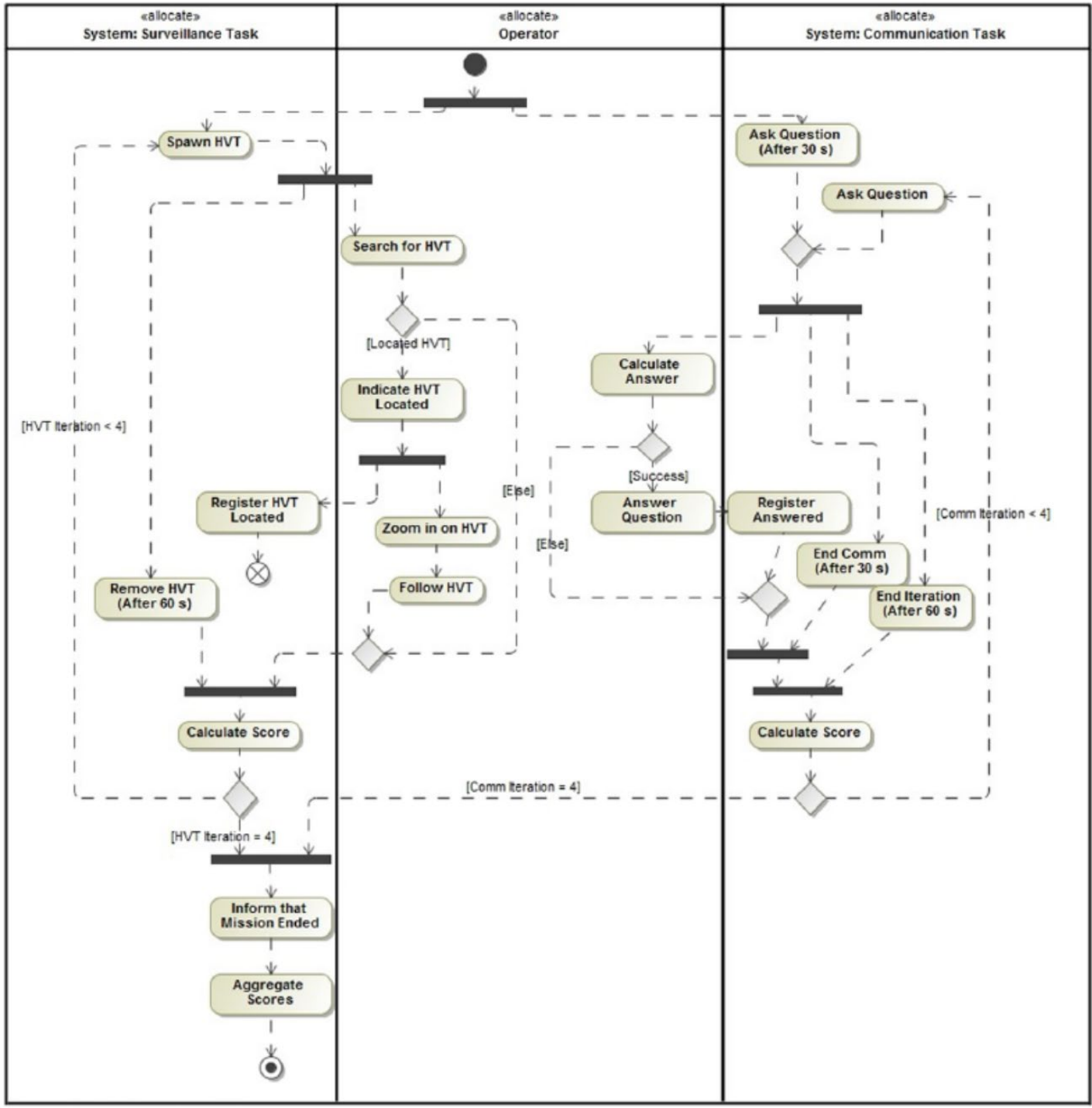
- "The DoD Component capability developer or program manager will formulate a comprehensive HSI program … including, but not limited to:"
  - An HSI management plan, as outlined in Service component HSI-plan guidance
  - The human engineering design approach for the operator and maintainer, which may include **a human viewpoint architecture description**
  - Task analyses
  - Analysis of human error
  - **Use of human modelling and simulation**
  - Usability and other user testing to support and inform human and machine interface analysis under operational conditions
  - HSI risk management
  - A training strategy for leaders, operators, maintainers, and support personnel

Human Views - Architecture (Bruseburg, 2008)



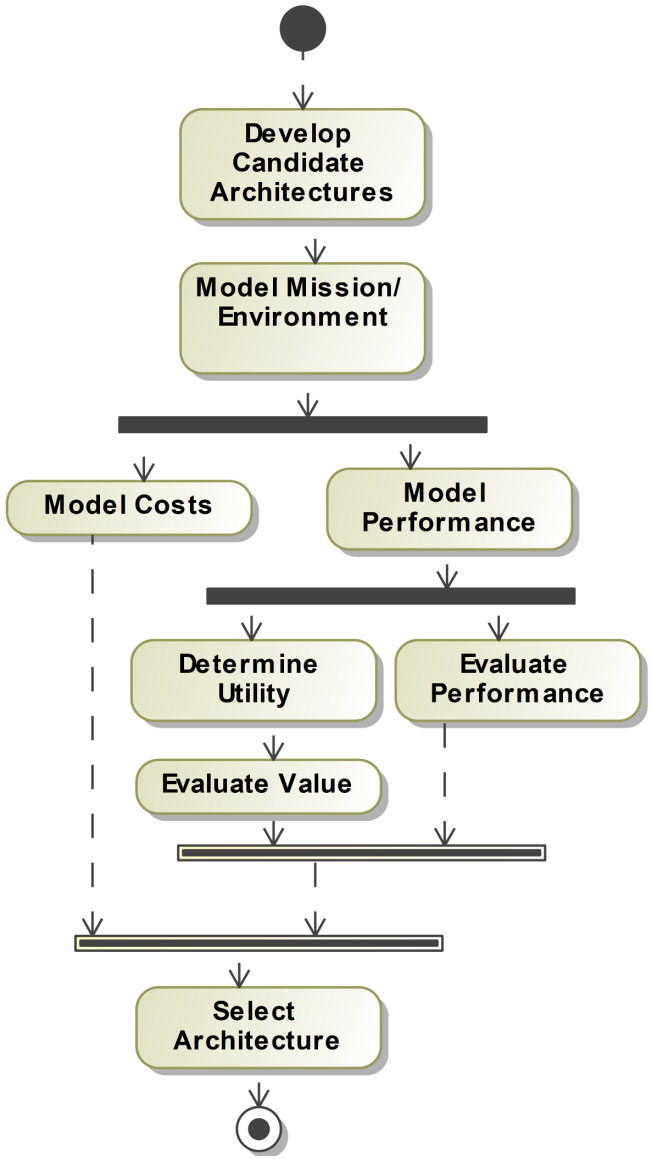
Simulation Watson et al (2018)





Why do we model? (Colombi et al. 2014)

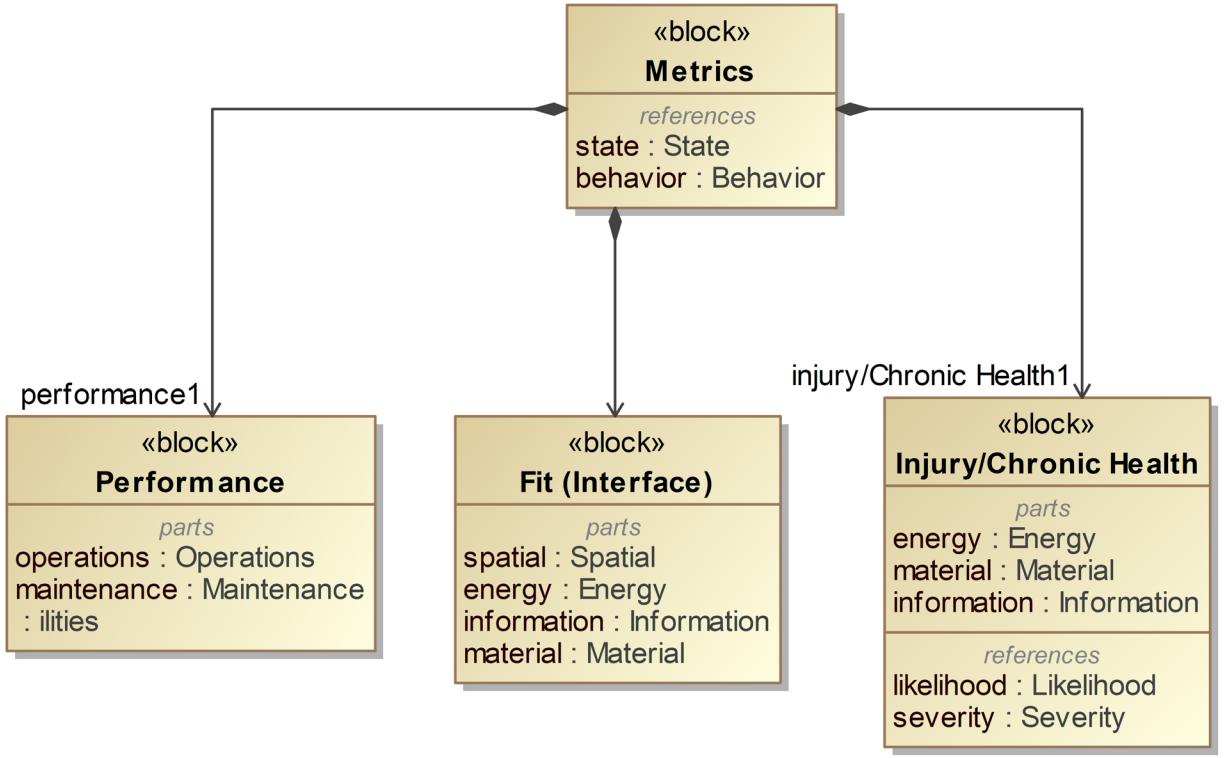
- Optimize Tradeoffs in Cost and Performance Among Various Designs
- Means to evaluate several system architectures early in system development process
- Can look at tradeoffs in HSI Domains as a function of System Designs – Human Factors, Safety, Occupational Health, Personnel, Manpower, Training, etc.



What do we Model: Proposed Taxonomy of Human Metrics

- Three Categories of Metrics
- Performance, including times and errors
- Fitness of Interfaces
- Injury or Chronic Health Effects

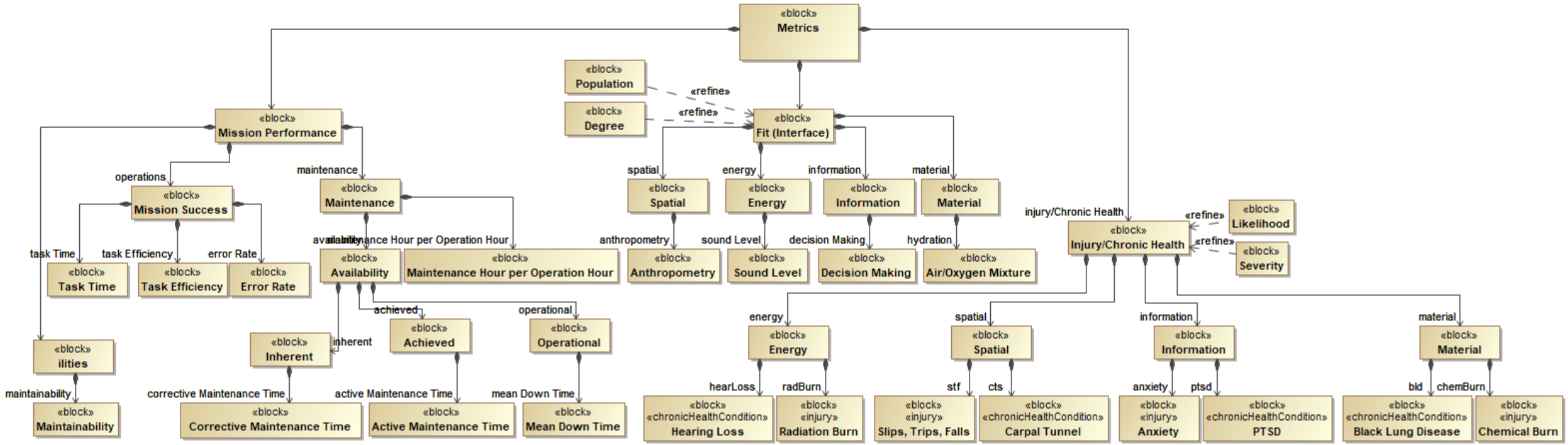
- Fitness and Injury/Chronic Health effects occur at interfaces
- Interfaces are Described by Spatial, Energy, Information, Material (Jain et al. 2010)



Overview

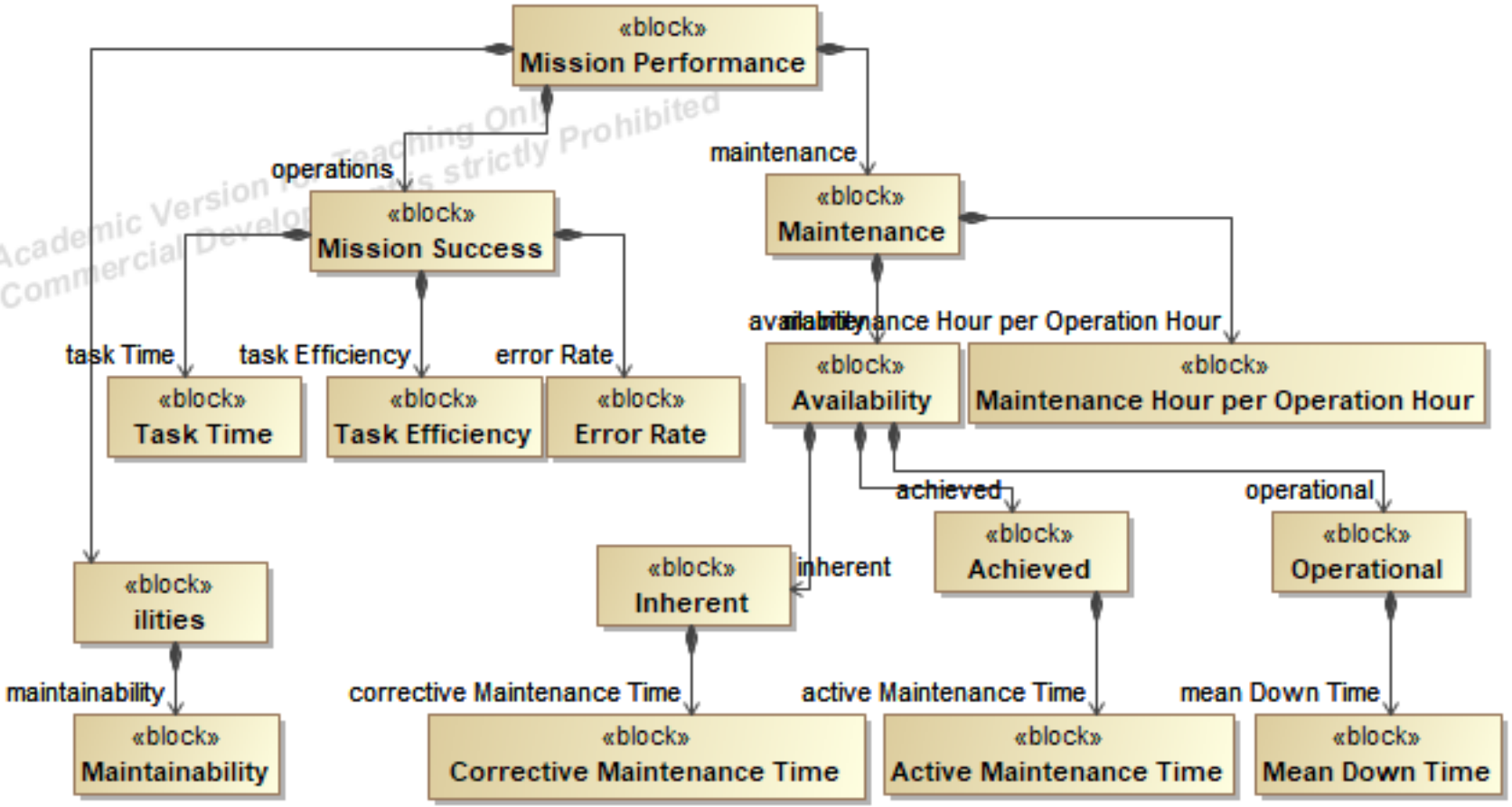
The AFIT of Today is the Air Force of Tomorrow.

- Examine the 3 Branches of the Taxonomy



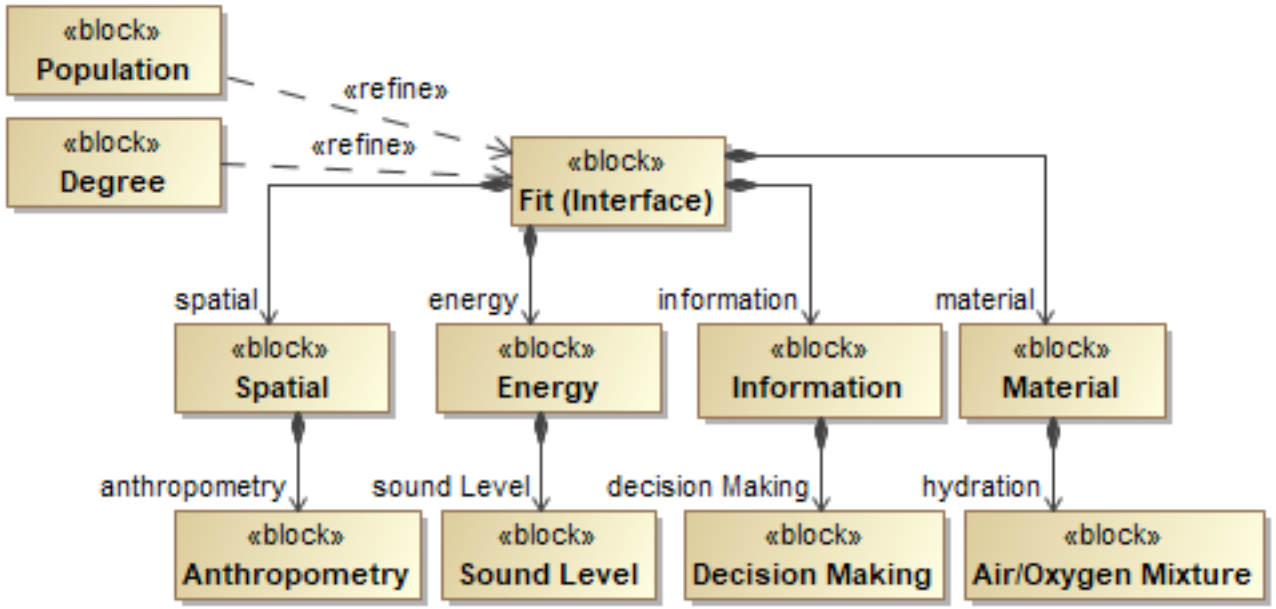
Performance

- Important to Link Human Performance to KPPs
- Lower Operator Performance Increases Manpower Requirements, Impacts O&S Costs
- With Available Manning System Availability may Suffer



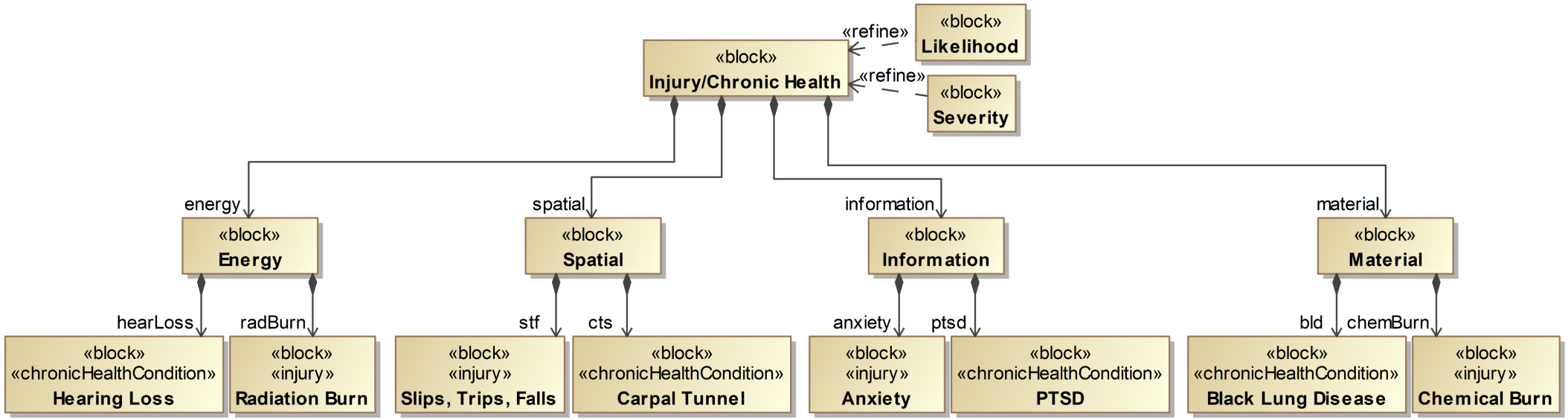
Accommodating Users

- Interfaces must be designed to support the user
- Must accommodate variability in human population
- Not independent of performance b complicating factor
- Must consider four dimensions of interfaces



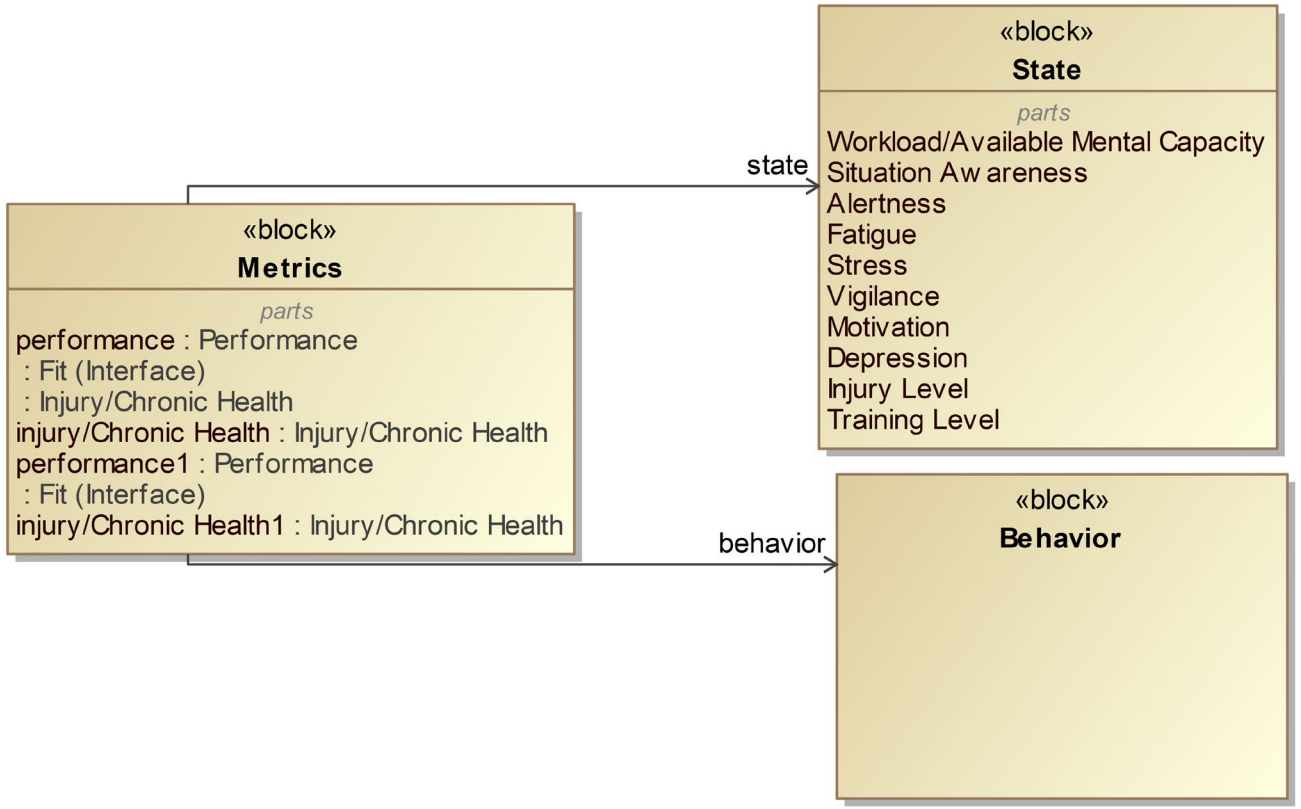
Injury and Chronic Health Risks

- Occurs at “unspecified interfaces”
- Severity and acceptable risk are not universally defined
- Although somewhat independent of performance, Injuries and PPE can degrade performance, increase manpower costs



Where are other common HF metrics?

- Metrics of human state and behavior are not intrinsically important to system design
- Impact, influence, provide insight to performance
- Behavior is intrinsically influenced by system design parameters
- Human state often influenced by environmental factors



Conclusion

- Digital Engineering and MBSE have the potential to expedite design decisions to earlier stages of the development process
- If human models are not constructed and integrated, these decisions may be made without insight into human influences
- A robust framework is required to support development of human modeling efforts – perhaps a taxonomy of metrics is an important starting point
- Standardization of framework models can advance the use of human representations in system models, improving human-system integration.

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