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Towards Pragmatic High-Confidence Design of Cyber-Physical Systems

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Issue #1: Tool Integration

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- CPS Design: an inherently multi-disciplinary and multi-paradigm process
- No single engineering tool can solve all engineering problems

  → Need tool integration
- Tool integration frameworks are already available

  → They support syntactic integration well, but to lesser degree semantics
  - OTIF, ModelBus
- Semantic interoperability is needed such that design tools seamlessly interoperate and exchange models, track model dependencies
- Issues: Toolchain engineering
  - Rapid evolution and configuration of tool chains
    - Manufacturing processes are updated regularly
  - Precise tool semantics is essential
    - Tool metamodels including semantics
  - Robust and verifiable model transformations for interconnecting tools

Issue #2: Model Integration

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- CPS: Heterogeneous modeling
  - Physical plant: continuous time with switching
  - Software: sampled-time, discrete-event, process networks, synchronous…
- Abstract: model of computation ←→ Concrete: model of execution
- Where the problems come up: Integration
  - Integrating tools
  - Integrating systems
- Issues:
  - Precise definition of MoC/E
    - Need frameworks for writing definitions
    - Tools must be precisely defined
  - Interactions among heterogeneous MoC/E-s
    - Interoperation across heterogeneous models

Issue #3: System Integration

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- CPS's complexity necessitates concurrent, continuous, and iterative system integration
  - Integration: Science or engineering?
- An approach: model-based integration
  - Initially, model everything and execute integrated models
  - Incrementally, replace executable models with 'physical' components (implementations)
  - Finally, all elements are implementations.
- Issues:
  - Migration from simulations to implementations
  - Maintaining design integrity across the different 'versions' of the system
  - Crossing abstraction levels (e.g. software to hardware) while retaining an integrated model