

Multiplicity in Modeling and Simulation

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- ◆ Multiplicity in Abstraction Level
 - ❖ What are ignored and what are considered
 - ❖ Different abstract level → different model

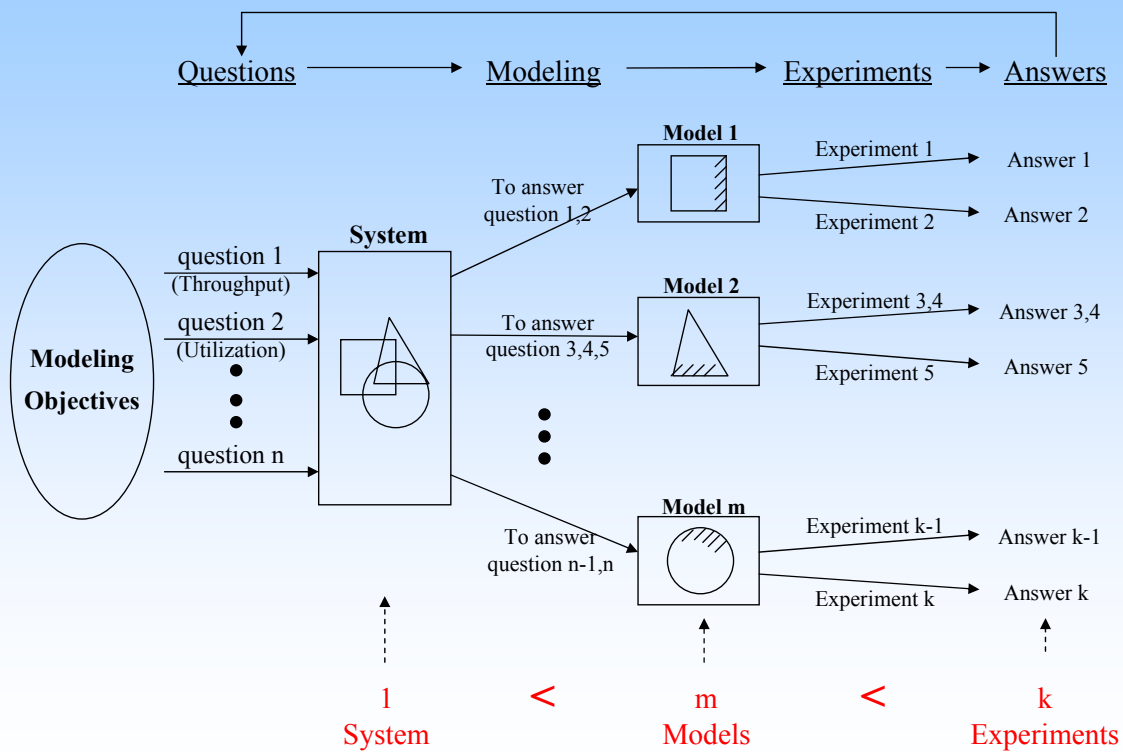
- ◆ Multiplicity in Resolution
 - ❖ Representation of a variable in different ranges
 - ❖ Multi-resolution modeling

- ◆ Multiplicity in Aspect
 - ❖ View of modeling
 - ❖ Different aspects of modeling → different models

- Decision of the multiplicities
 - Objectives of Modeling and Simulation

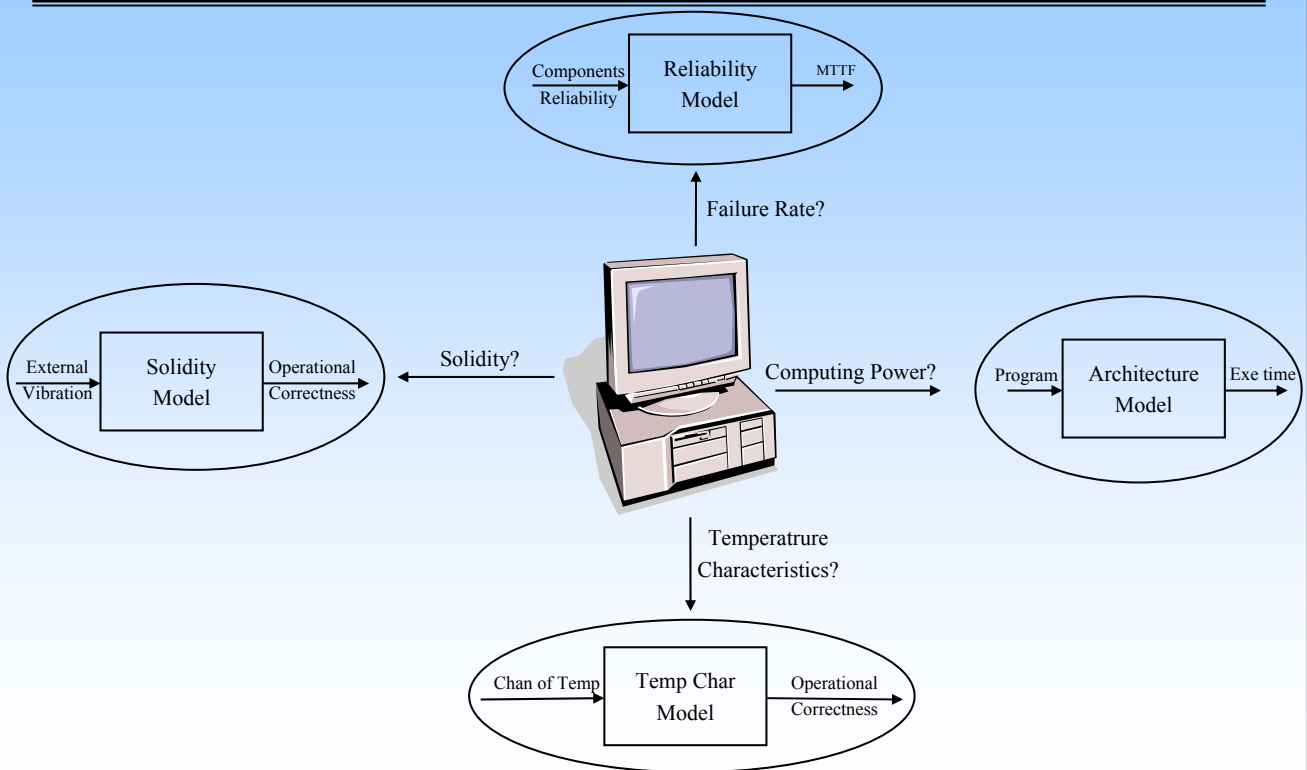
Objective-driven Modeling Simulation: Concept

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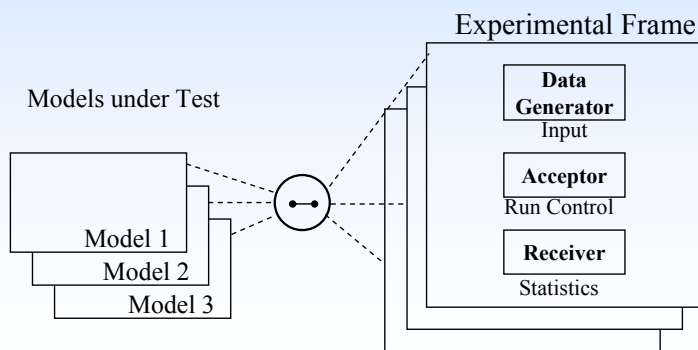
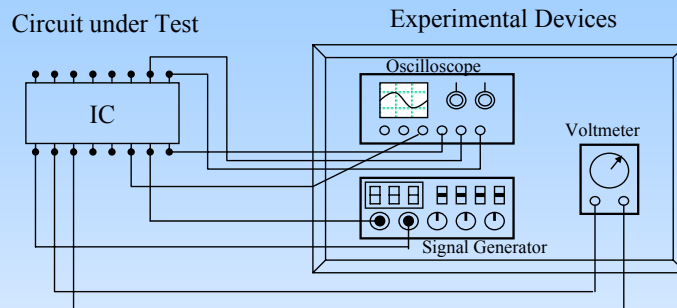
Objective-driven M&S: Example

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Experimental Frame Concepts

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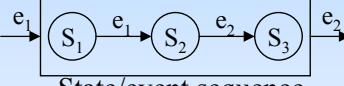
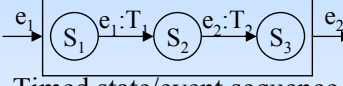


Simulation of Combinations

- (i) Alternative scenarios with an experimental frame
- (ii) A scenario with alternative experimental frames

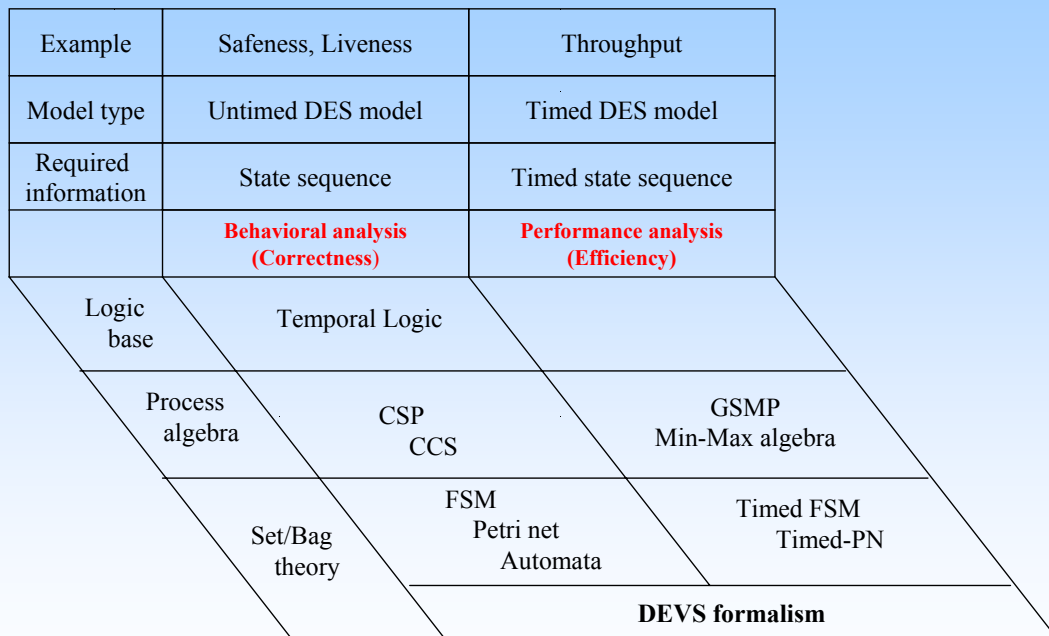
Purpose of DES Modeling/Simulation

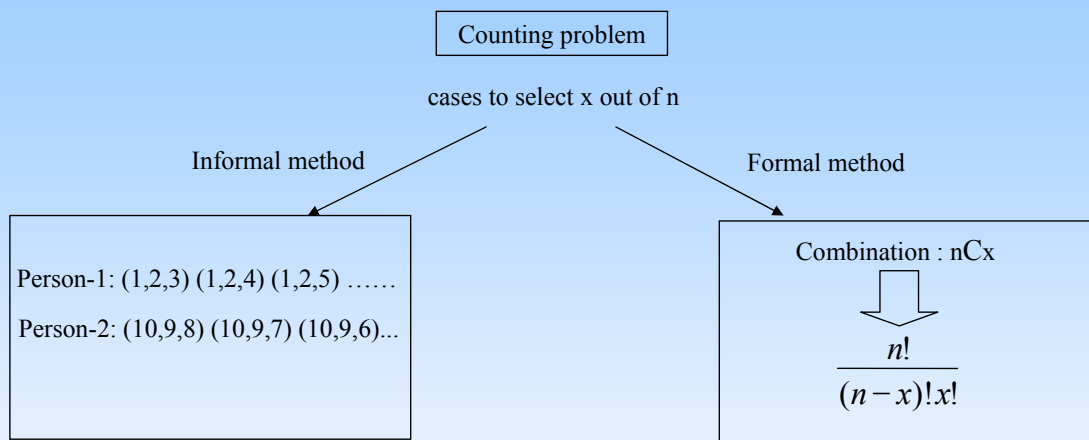
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	Logical/Behavior Analysis	Performance Evaluation
Example	Properties (Desired states sequence) Safeness (Bad things will not happen) Liveness (Good things will eventually happen)	Average waiting time Throughput Utilization
Required Information in Modeling	 <p>State/event sequence</p> Untimed (time unspecified) DES Model	 <p>Timed state/event sequence</p> Timed DES Model
Event Order in Time	Unordered/partial ordered	Totally ordered
	Untimed DES \supseteq Timed DES	
Complexity	High	Low

Math Formalisms for DES Analysis

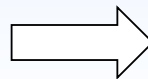
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◆ Advantages of Formal Methods

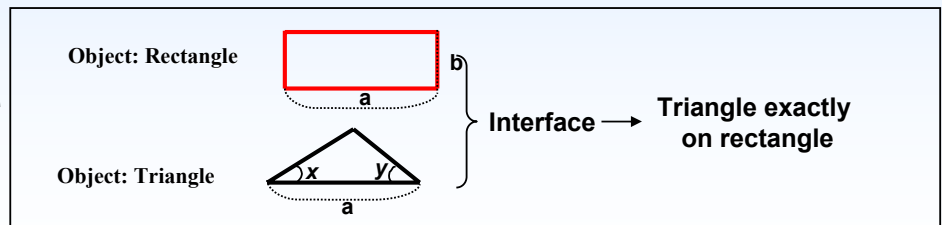
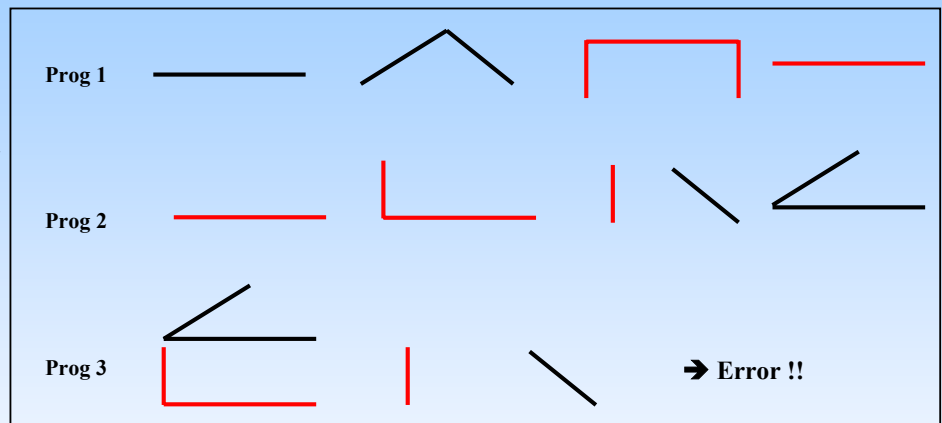
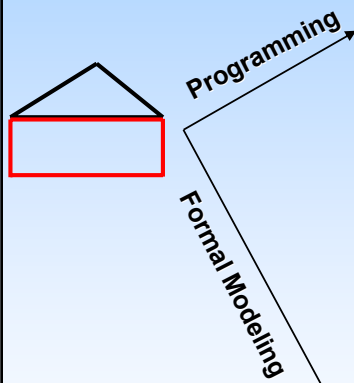
- ❖ Completeness
- ❖ Testability
- ❖ Communication means
- ❖ Mathematical manipulation



Analysis and Design
of
Complex System

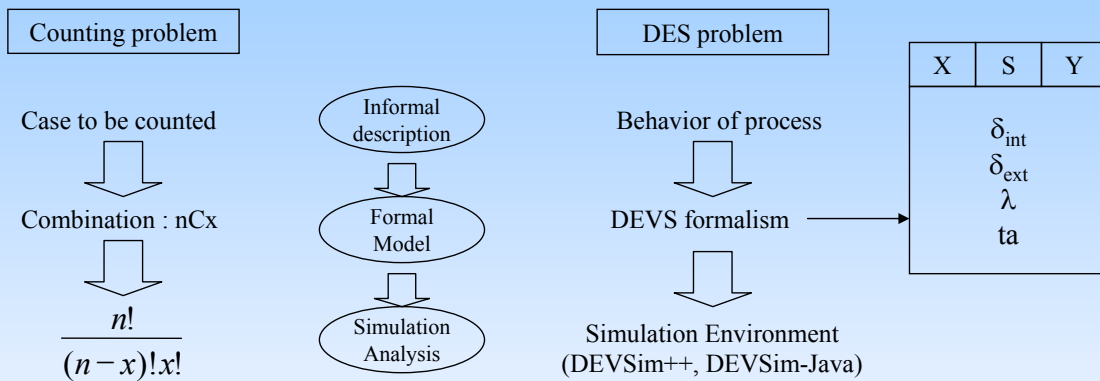
Programming vs Formal Modeling

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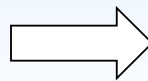
Formal Modeling Framework: Combination vs DEVS

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◆ Advantages of Formal Methods

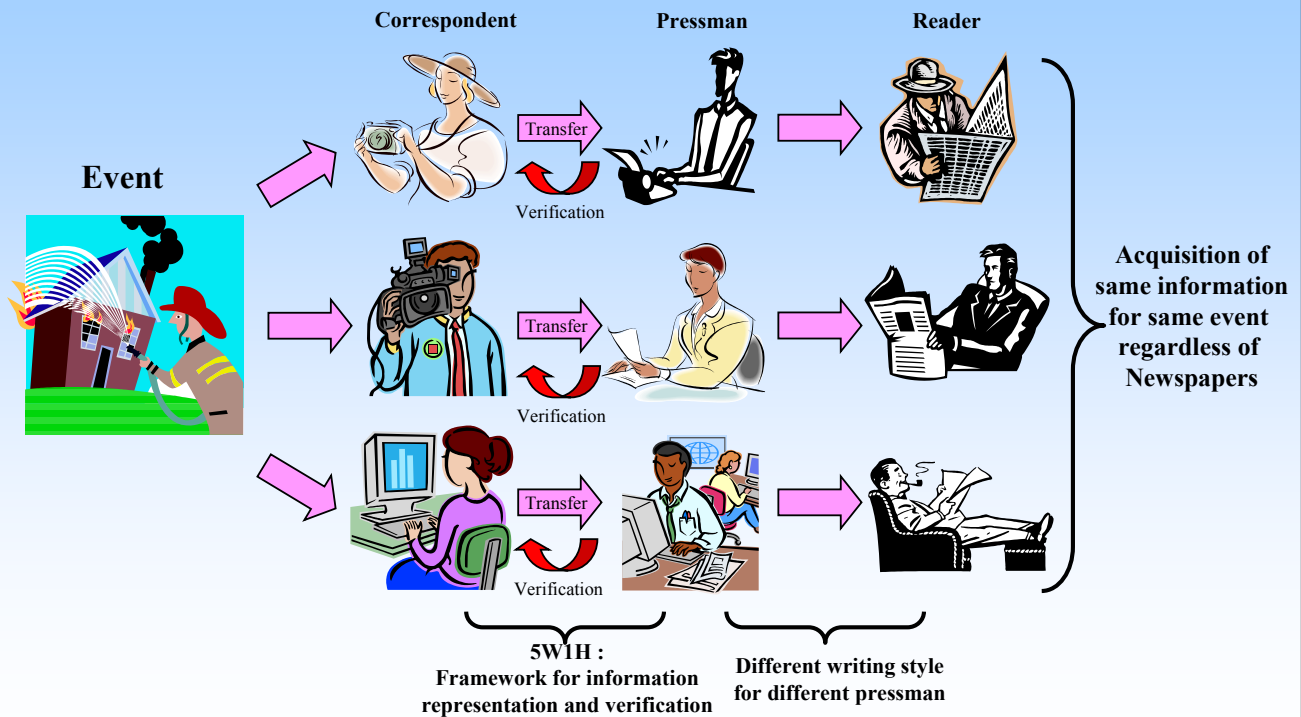
- Completeness
- Testability
- Communication means
- Mathematical manipulation



Group Working for Modeling of Complex Systems

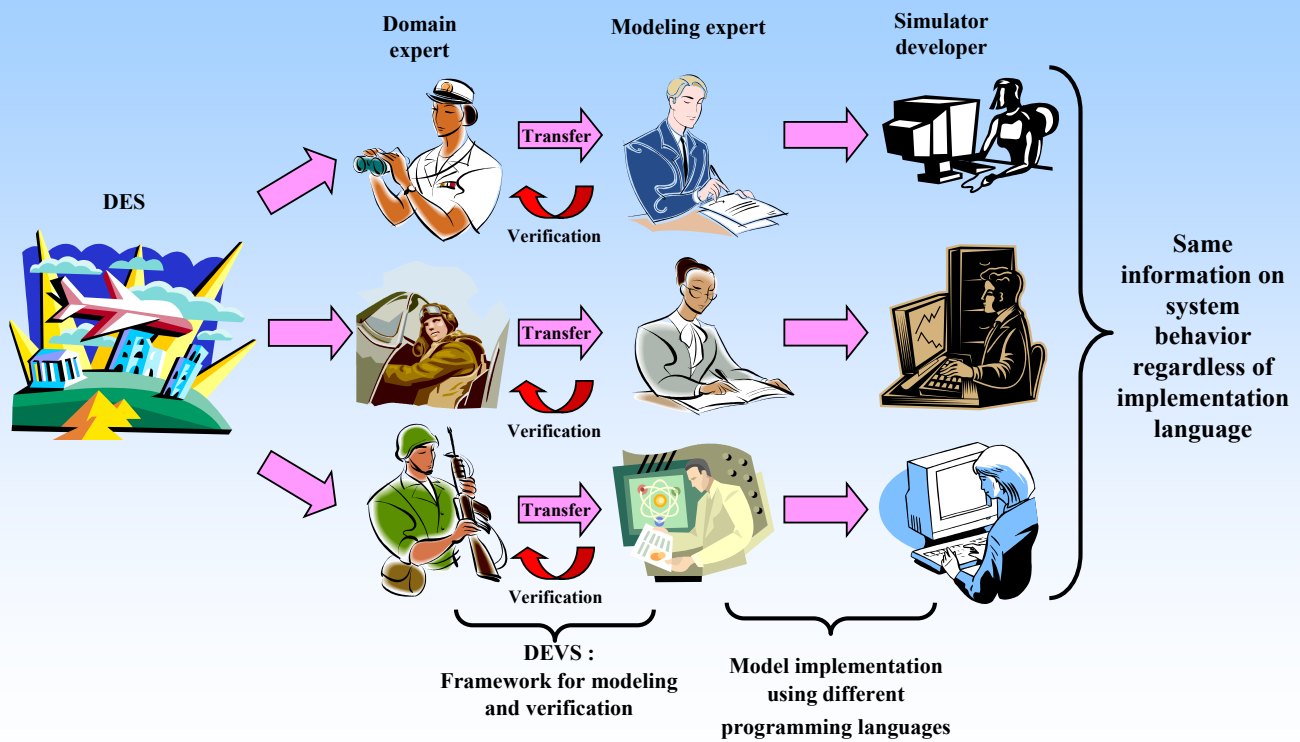
Framework for Writing Newspaper Article: 5W1H

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Framework for Discrete Event Modeling: DEVS(3S4F)

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Why Framework for Information Modeling

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- ◆ **Completeness**
 - ❖ Check what's missing in 5W1H / 3S4F

- ◆ **Verifiability**
 - ❖ Check each of 5W1H / 3S4F in a model against the real system

- ◆ **Modifiability/Extensibility**
 - ❖ Modify/extend each of 5W1H / 3S4F independently

- ◆ **Efficient Maintenance**
 - ❖ Maintain each of 5W1H / 3S4F separately

Method for DES Simulation Modeling

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	Method	Example	Merits/Limitations
Informal Modeling	Modeler's world view of system behavior	Event-oriented Process-oriented Activity-oriented Object-oriented	Simulation language based Easy to modeling Impossible to manipulate mathematically
Formal Modeling	Mathematical representation of system behavior	<i>DEVS Formalism</i>	Sound framework Mathematical manipulation General purpose language Cost for learning