CSSE 490 Model-Based Software Engineering: Cougaar Model-Driven Architecture Example

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Learning Outcomes: MBE Discipline

Relate Model-Based Engineering as an engineering discipline.

- Discuss Term Paper
- Introduce the notions of Model-Based Systems Engineering
- Explore System Models
- Topics for Term Papers (if time)

# Recall: Write & Present Term Paper

- **Use IEEE/ACM format for the paper (template provided on Angel)**
- **Include abstract, introduction, background/ related work, analysis, and conclusion (along with references)**
- **Target 5-7 pages**
  - □ **If you are not a strong writer, use a lot of tables and figures to organize your work**
- **Use your own words - copied elements without reference are considered plagiarism**
- **Paper due May 17th, 2011**
- **Presentation on May 19th, 2011**

Recall: Topics for Term Paper

1) Critically analyze the state of software productivity and the potential for Model-Based Engineering to make an impact.

2) Conduct a survey of Model-Based Engineering approaches (e.g., MDA/MDD, MBSE, DSL, MIC, etc.) to compare and contrast them.

3) Survey Model-Based Engineering in other disciplines (e.g., civil, mechanical,) comparing them with MBSE.

4) From a macro-economic perspective, evaluate the cost-benefit of Model-Based Engineering for software.

5) Critically analyze advances in automatic programming from a feasibility perspective and outline how these implications are relevant for software today.

6) Survey applications of "Product-Lines" to software systems and present arguments for a Model-Based Engineering approach.

7) Critically analyze transformation technology in the production of Model-Based/Driven Engineering software solutions.

8) Survey studies of Model-Driven Architecture (MDA) for the state-of the practice and outline key criteria for success and failures.

9) Suggest one that you would be more motivated to do!

Newtonian Systems
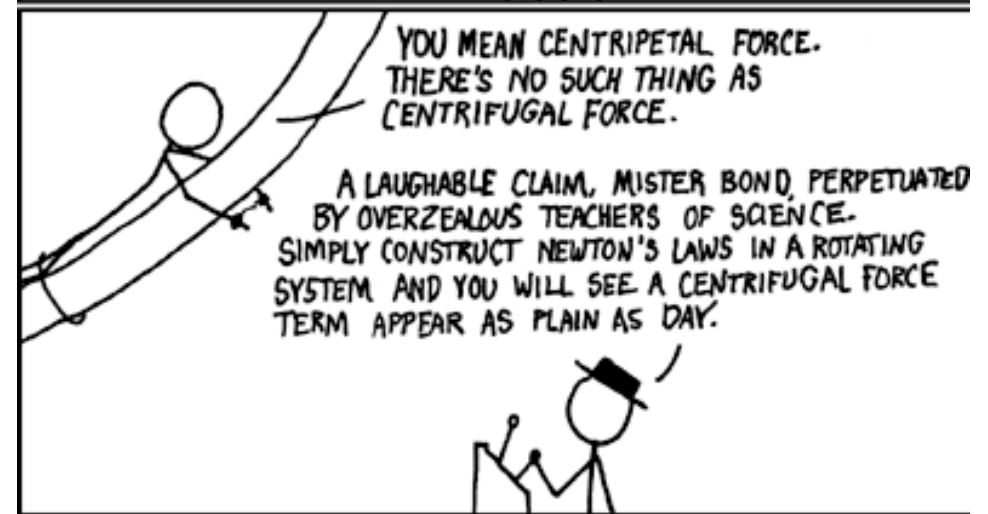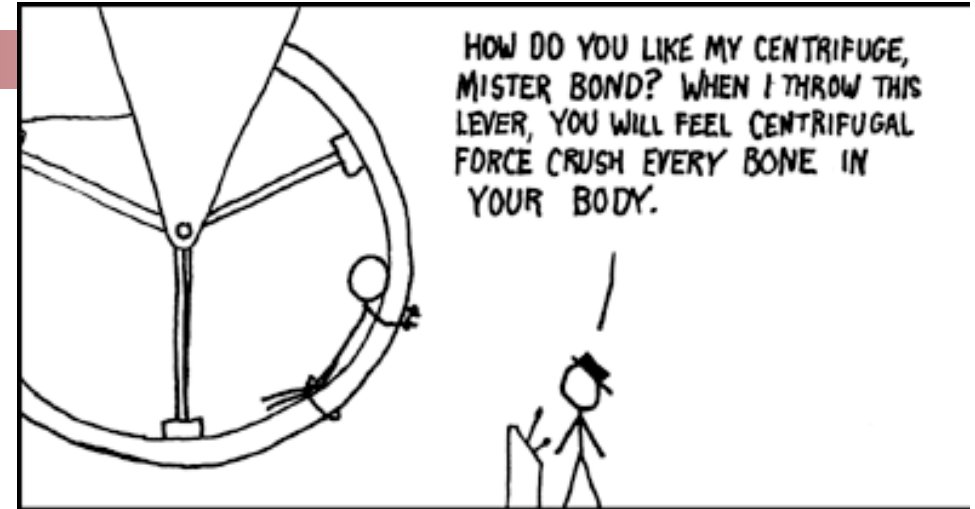
# We have been talking about Software, but what about Systems?

If Model-Based Engineering is useful for software, what does it provide for other engineering disciplines?

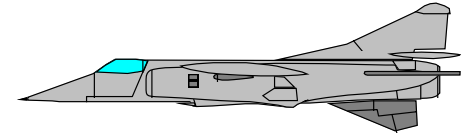- Think for 15 seconds…
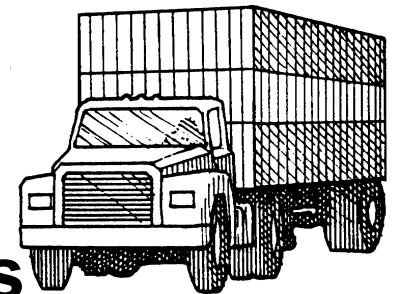- Let's talk…

Model-Based Systems Engineering

MBSysE is a systems engineering approach using explicit models where previously informal, intuitive, natural language prose of documents was used

Model

Modeled Thing

Model Interpreter

Processor Farm
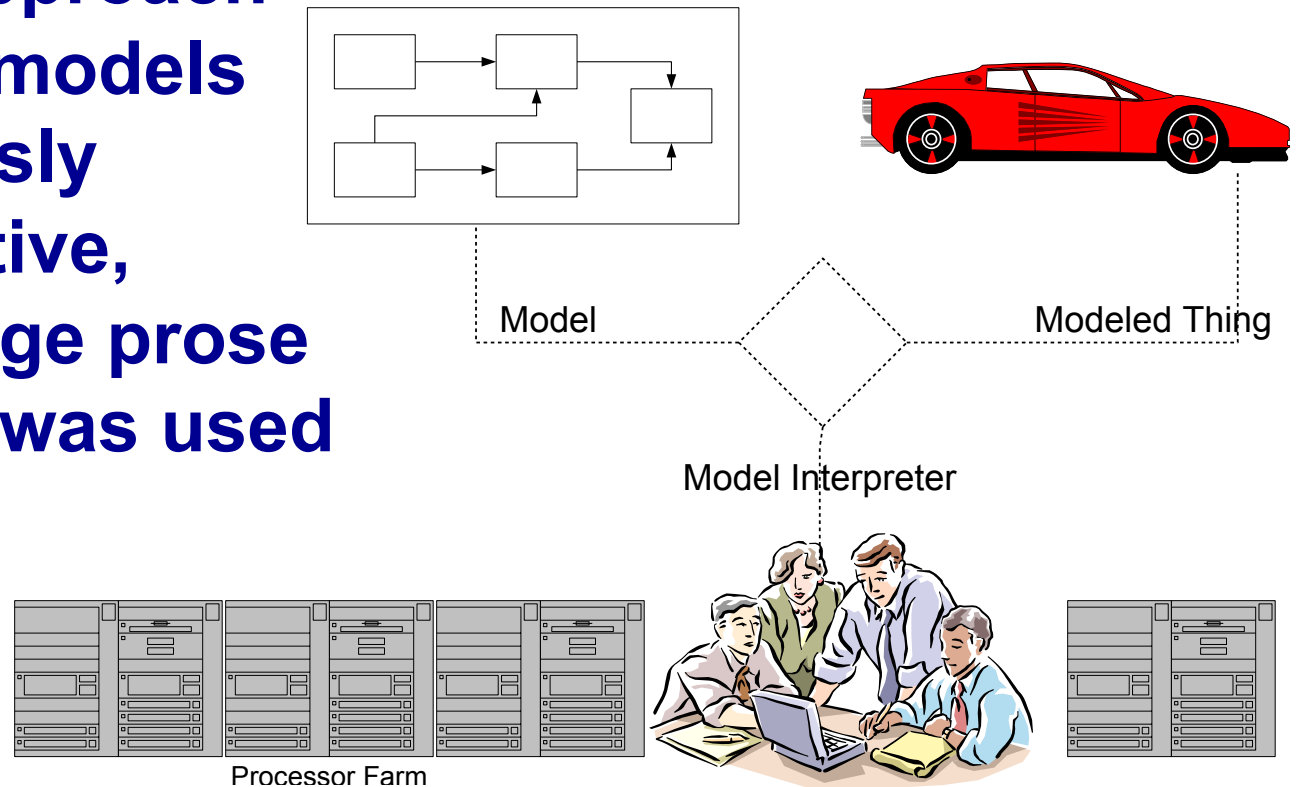
The Man-Made World Is Increasingly Populated by Systems

- **Transportation, Energy & Power Systems**

- **Manufacturing, Construction Systems**

- **Telecommunication Networks**

- **Man-Made Biological & Health Care Systems**

- **Facility, Properties**

- **Business Processes**

- **Other Man-Made and Natural Systems**
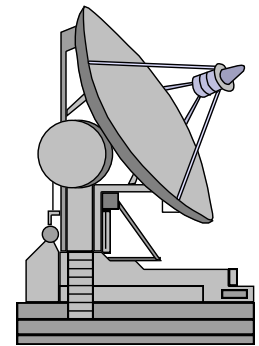
Systems Engineering entails Interdisciplinary Involvement

Software Engineering

Electronic engineering

Mechanical engineering

Structural engineering

Systems Engineering

User interface design

Civil engineering

Electrical engineering

Architecture
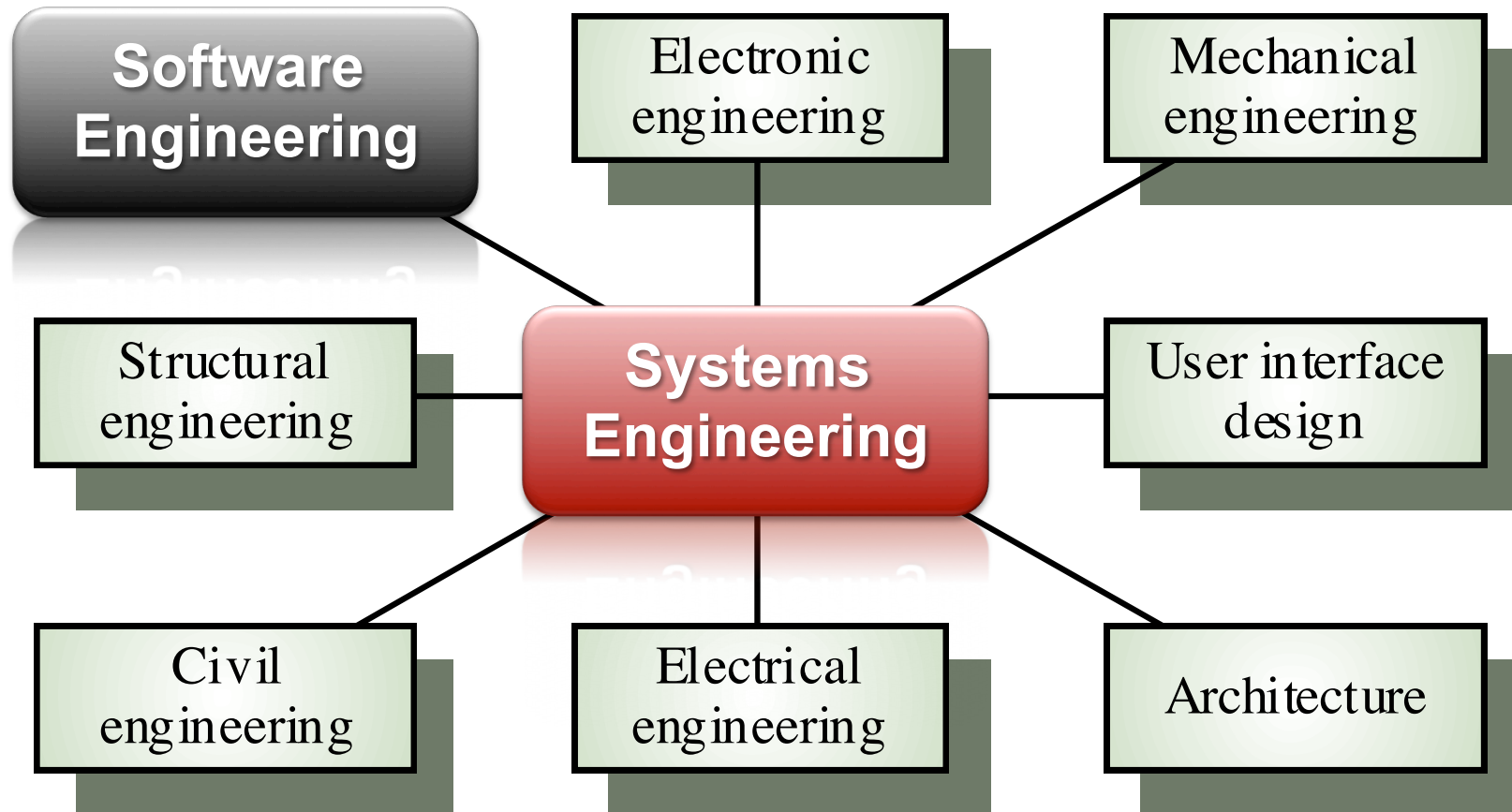
The Systems Challenge

Growth & Complexity Outpacing Human Ability to:

- Describe
- Predict
- Manage
- Monitor
- Configure
- Evolve

- Understand
- Install
- Operate
- Repair
- Maintain
- Account For

- Communicate About
- Design and Implement
- Manufacture
- Diagnose
- Control

Not Everything that has Parts is a System

- For components to "interact," there must be an concept of "state" and relationship between states of components

- This distinguishes the engineering view of systems from "systems" in some other fields.

Example System: Freight Hauling

- **Components**: engine, power train, suspension, lubrication system, fuel system, braking system, electrical system, cab, trailer, navigation system, communication system, software modules

- **Relationships**: physical containment, power dependency, control interaction, mechanical connection, thermal interaction
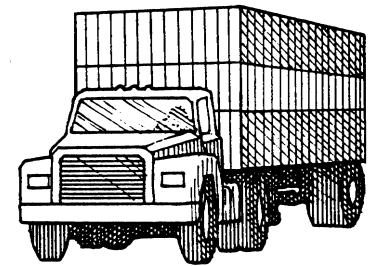
Physical and Logical Systems

- **A Logical System is equivalent to a functional role**

- **Physical Systems may be assigned responsibilities to perform roles that are Logical Systems**
  - **What plays the role of Engine System in a lawn mower?**
  - **What plays the role of Engine System in a hybrid automobile?**

Example of Logical System:	Examples of Physical Systems:
– Engine System: An Engine System converts atmospheric air and chemical fuel into rotating mechanical power for use by other machine subsystems.	– Jeep Liberty CRD vehicle – Caterpillar Model 3406 Diesel Engine – Program Module 3367

Lawn Mower Example

Servicing

service complete

service request
received

Shut Down

start request received

Starting

lawnmower started

Idling

disengage mowing

engage
mowing

Normal Mowing

shut down initiated

normal shut down completed

Shutting Down

overheat recovery complete

overheated shutdown completed

Overheat Recovering
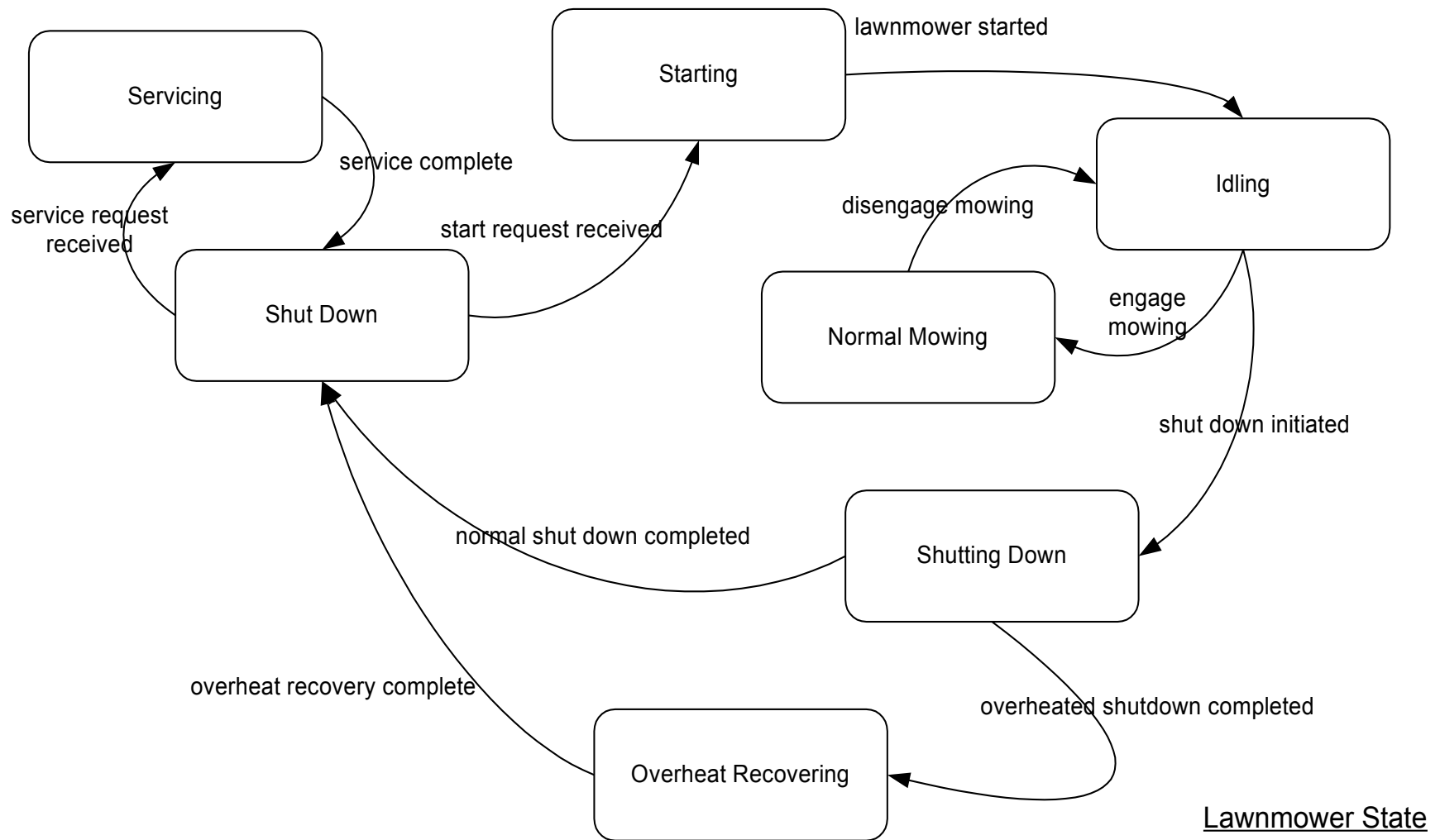
Lawnmower State

Functions

- ## A <u>function</u> is often an <u>interaction of systems</u>
  - □ Systems fill <u>functional roles</u> in these interactions
- ## Example:
  - □ Function = Start Mower
    - ■ Roles = Operator, Controller, Mower Clutch, Engine

Function: Start Mower

| :Operator | :Controller | :Mower Clutch | :Engine |

1: Request start

2: Verify disengaged

3: Acknowledged

4: Start

5: Started

6: Signal running

Systems, States, and Functions

- **Systems describe "who" performs interactions**

- **States describe "when" interactions occur**

- **Functions describe "what" are the interactions**
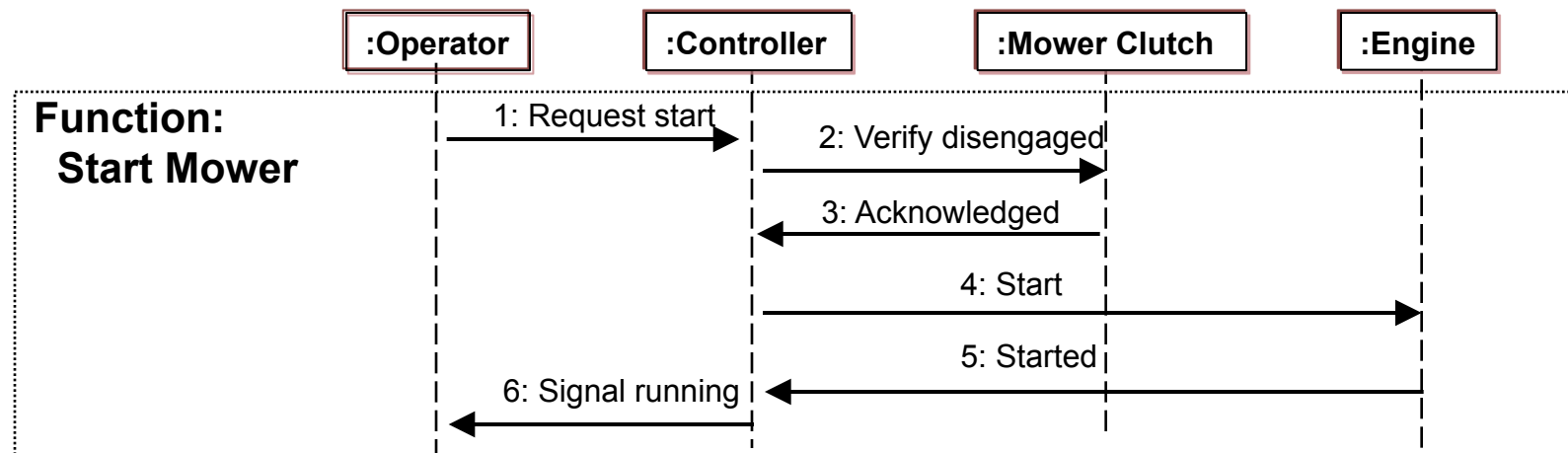
More on Lawnmower Example

Starting

Mowing

Shutting Down

Functions:
1. Start *(<10 seconds of turning key)*
2. Check Starting Interlocks *(blades must be disengaged)*
3. Noise control *(conform to ASPE 102.3 noise guidelines)*
4. Emission control *(conform to EPA 11.2 emission guidelines)*

Functions:
1. Cut grass *(to operator determined length)*
2. Noise control *(conform to ASPE 102.3 noise guidelines)*
4. Emission control *(conform to EPA 11.2 emission guidelines)*

Functions:
1. Disengage blades
2. Shut down engine

Lawnmower Starting Example

Operator —1: Request start→ Controller —2: Verify disengaged→ Mower Clutch

4: Start → Engine

6: Signal running (Controller → Operator)

3: Acknowledged (Mower Clutch → Controller)

5: Started (Engine → Controller)
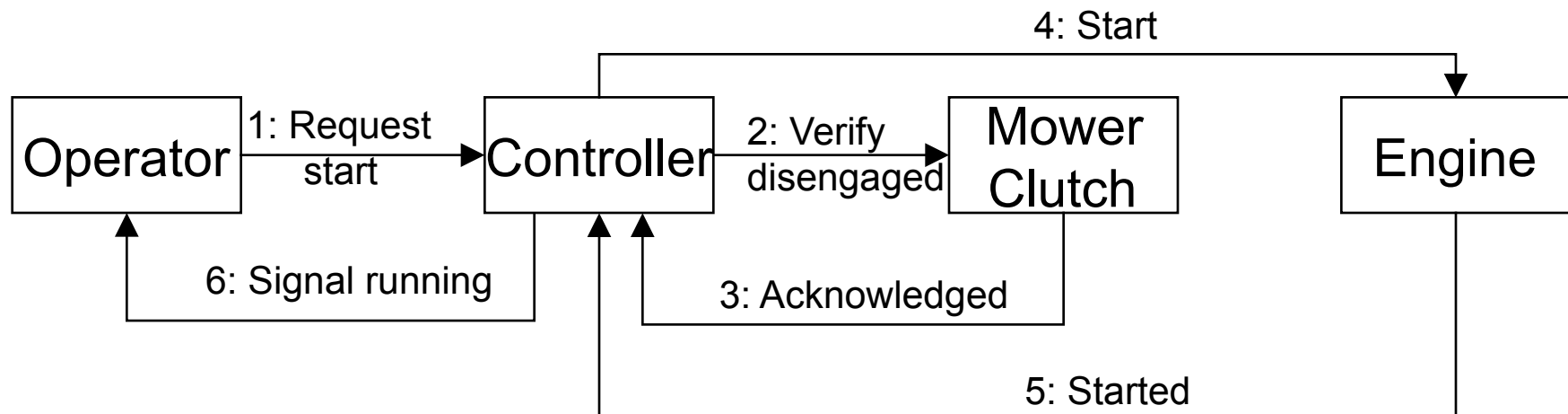
Conditional Risk in Natural Systems
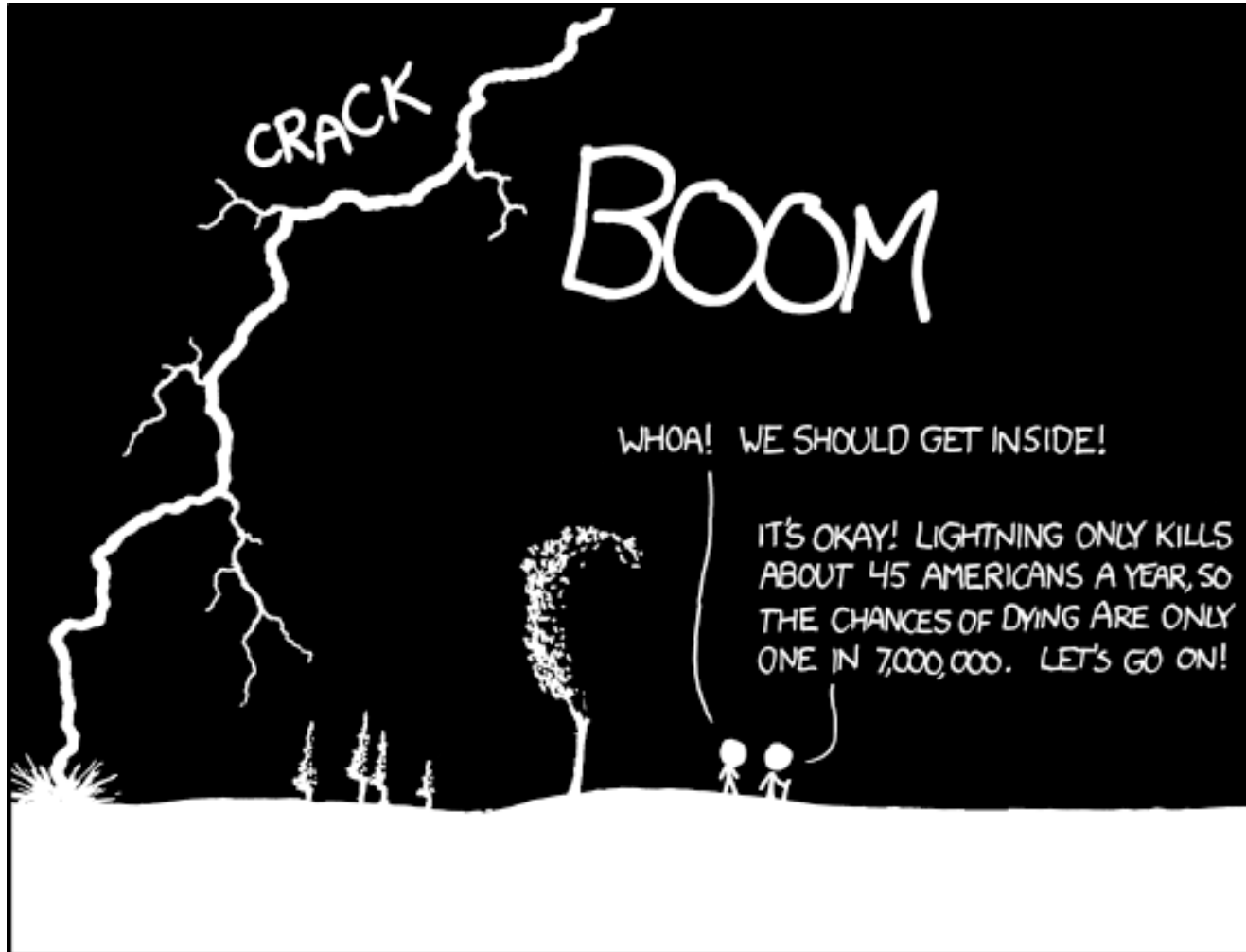
Have you noticed...

- **That so far we talk about modeling things (largely) the same way that we model software**

- **The difference is that software is enacted to be operational while systems are often simulated**

- **Note also the large degree to which software plays a role in today's systems**

System Hierarchies

Town

Street

Building

Heating system	Power system	Water system
Security system	Lighting system	Waste system
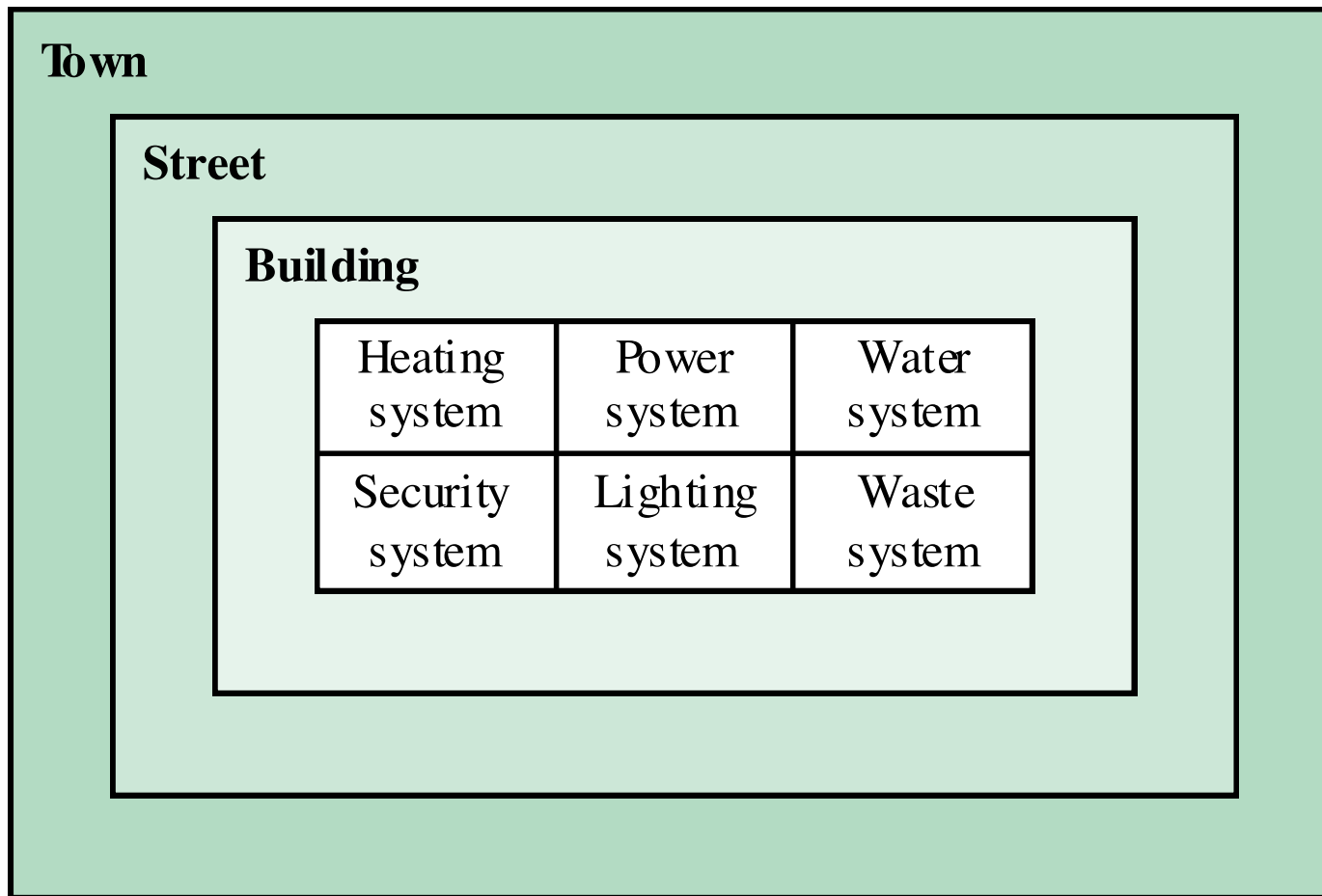
:
County
State
Country
World
Galaxy
:
Universe?

Homework and Milestone Reminders

- **Read Case Study Paper "Model-Driven Systems Engineering" by Balmelli et. al.**
  - ☐ **To be discussed in Class this Thursday**
  - ☐ **Do assigned questions and bring document to class**
  - ☐ **Be prepared to discuss and even lead the discussion**

- **Milestone 3: Light-Weight Transformation Environment (see Milestone 3 assignment)**
  - ☐ **Due by 11:55pm, Friday, April 29th, 2011.**