

CSSE 490 Model-Based Software Engineering: More Software Factories



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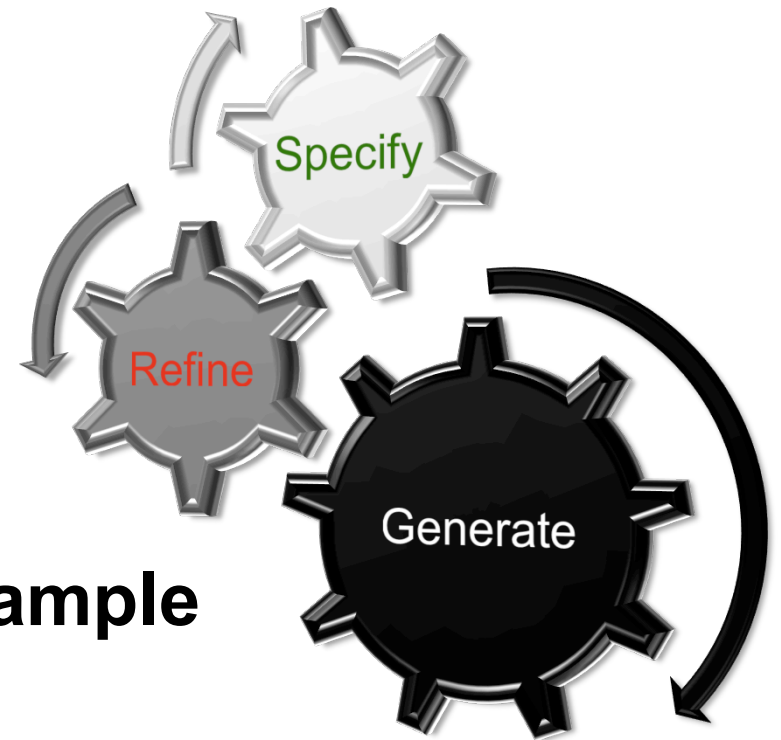


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Learning Outcomes: MBE Discipline

Relate Model-Based Engineering as an engineering discipline.

- Finish Software Factories
- Examine Executable UML
- Short Action Language Example
- Recipe Framework for Manual Code Inclusion



Recall: Software Factories

- 1990's Software Factories emerged as the new automated programming
- Faced an untrained community coupled with limitations in computing capabilities
 - The Virtual Software Factory
 - Software Templates
 - Software Refinery
- Devolved into IDEs configured for efficient development of Domain applications (led by Microsoft these days)

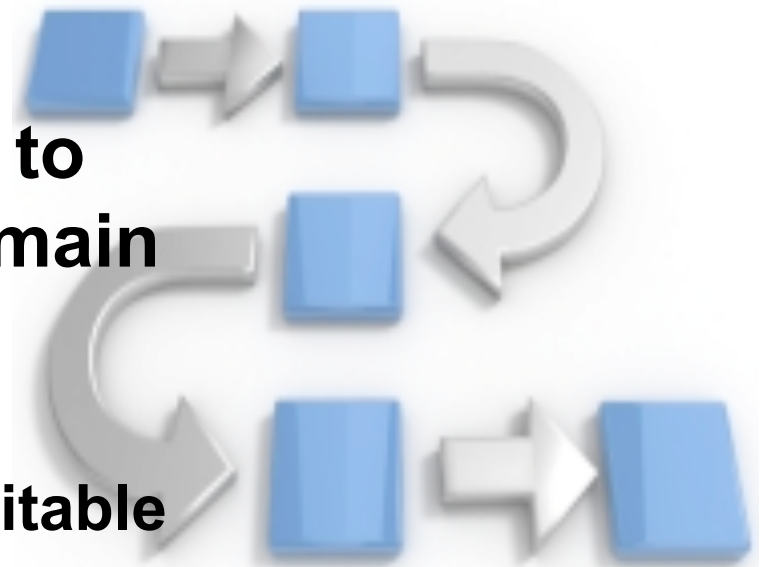


Recall: Software Factories Schema

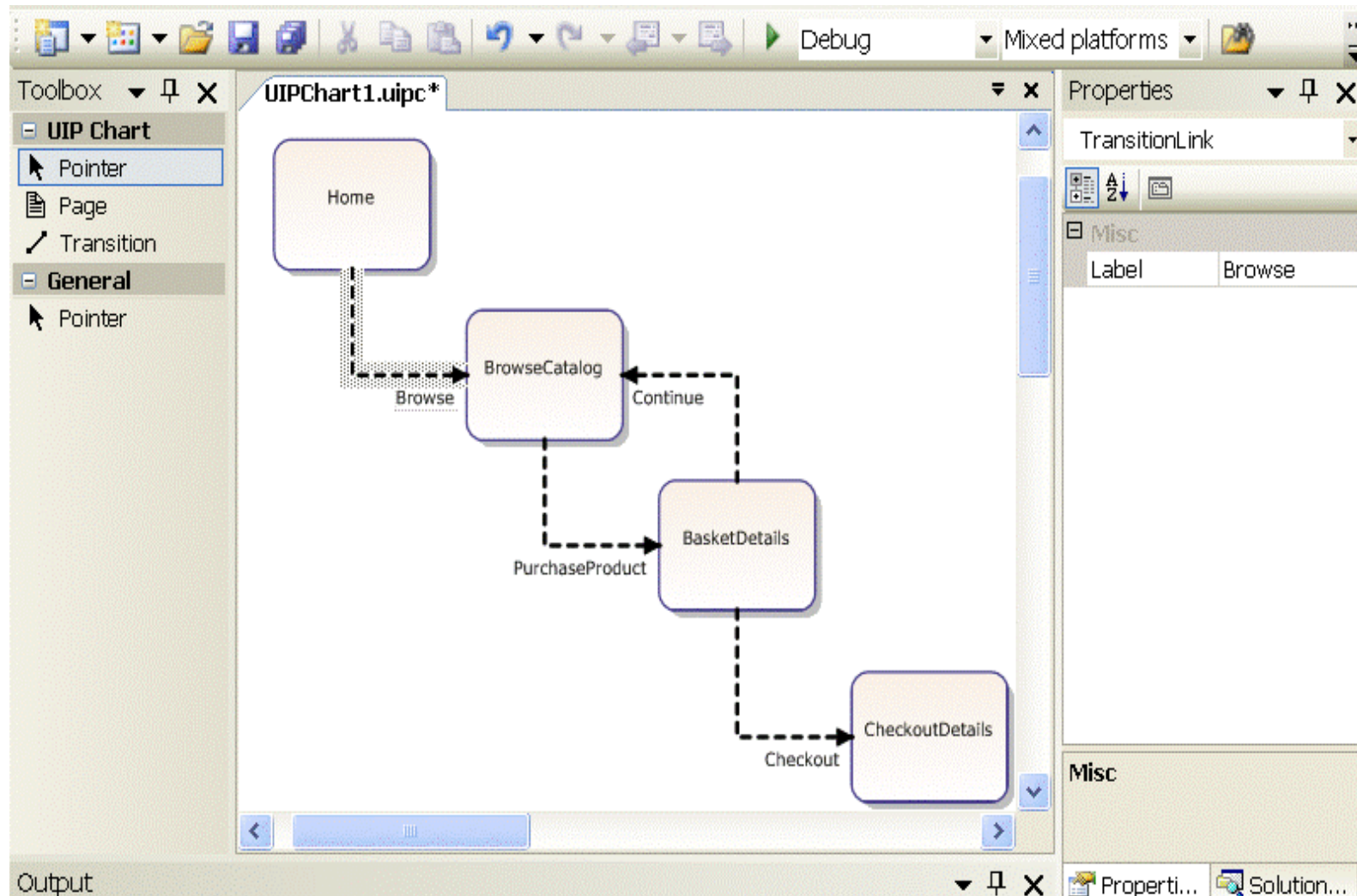
- Schema defines viewpoints for modeling and building a system (e.g., enterprise system):
 - Presentation, form layout and workflow
 - Component structure and business data model
 - Persistence mapping, Deployment, ...
- Schema identifies core artifacts as well as the most efficient way of producing them
 - DSLs, frameworks, patterns, manual programming
- Schema identifies commonalities and differences among applications in the domain

Software Factories Templates

- **Makes the Schema usable**
- **Load SF Template into IDE to configure it for specific domain**
 - Provides the necessary frameworks or libraries
 - Contributes project types suitable for the factory
 - Delivers build scripts
 - Extends IDE with DSL editors and transformations



MS DSL Tools Example



Defining a Metamodel

The screenshot displays the Visual Studio IDE with a UML metamodel diagram for 'ReseaudPetri'. The diagram shows a hierarchy where 'Element' is the base class, with 'Jeton', 'Place', and 'Transition' as subclasses. 'Element' has a self-referencing association 'ReferencedE'. 'Place' has associations 'Jeton' and 'Transition'. 'Transition' has an association 'TPlace'. There are also several association classes: 'ElementHasElement', 'PlaceHasJeton', 'PlaceHasTransition', and 'TransitionHasPlace'. A 'RDP' class is associated with 'Element' via 'Elts'. The Solution Explorer on the right shows a project structure with resources, shell, and templates folders, and various code files. The Output window at the bottom shows a successful build log for the 'ReseaudPetri' project.

```
ToolWindow: Example.ReseaudPetri.Designer.ReseaudPetriModelExplorer, {c5bd4cf5-1704-4ca7-9b70-8b946a763781}
Editor Extension: .rdp, {a29fab9e-fa92-4582-8450-8cd792d85bab}
LoadKey: ReseaudPetriPackageName
Version 1.0.0.0
Edition Required: Standard

SUCCEEDED: Example.ReseaudPetri.Designer

===== Build: 1 succeeded, 0 failed, 2 up-to-date, 0 skipped =====
```



Software Factory and MBSE's

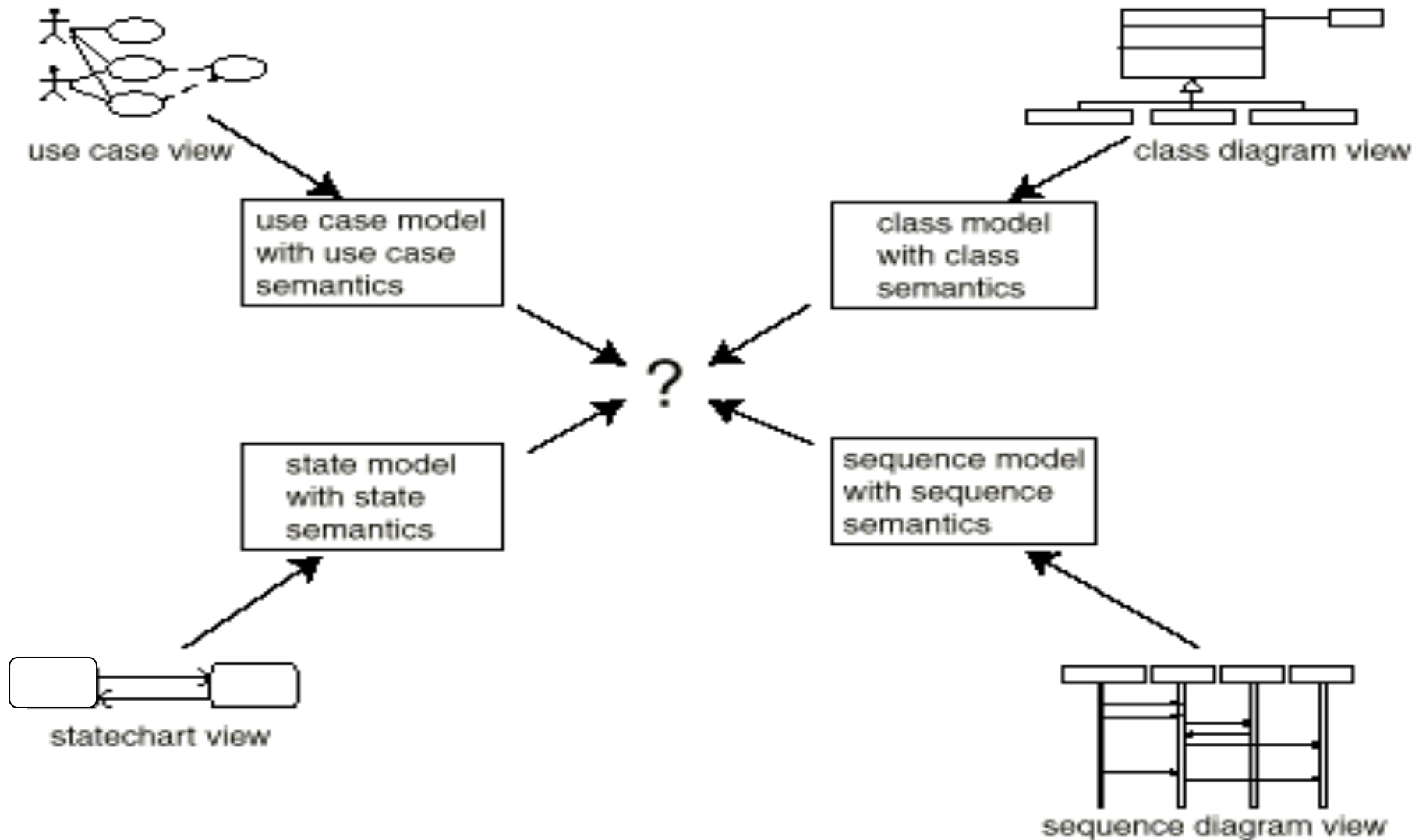
- **SFs use model-based concepts without major changes**
 - DSLs are used to build models, Languages often graphical
 - Some provide tooling to define the metamodels as well as concrete syntax and editors

- **SFs seldom use OMG standards for their infrastructure**
 - DSLs are not UML based
 - Metamodels are not based on the MOF, and not QVT

- **Application developer's perspective**
 - Models are first class artifacts in development projects
 - Editors and transformations integrate seamlessly with the IDE

- **Infrastructure developer's perspective**
 - Metamodels, editor definitions and transformations are first class artifacts
 - Tools to build them are seamlessly integrated into the IDE

Same Semantics for Different Views

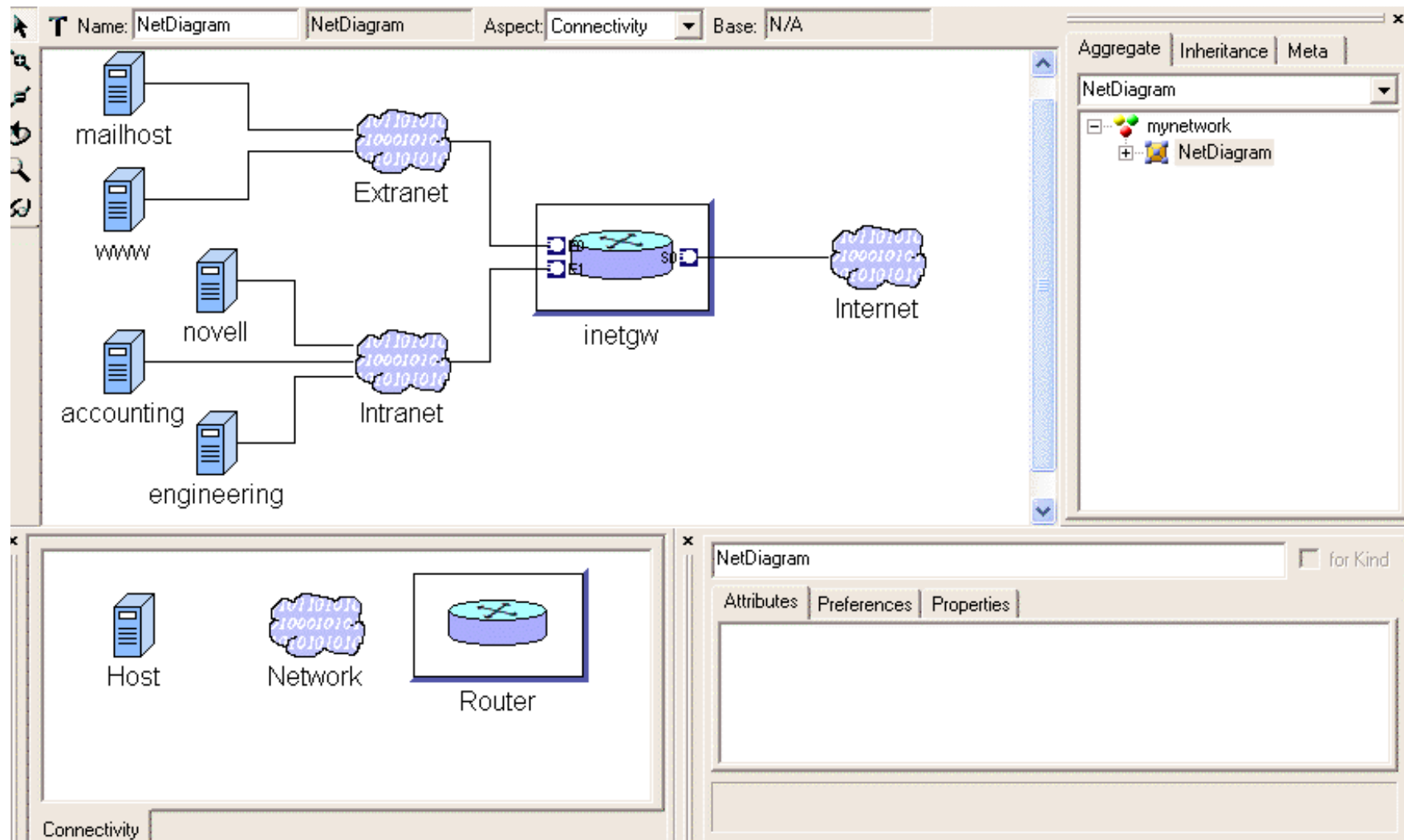


Graphical Model Editor

The screenshot displays a graphical model editor interface with several key components labeled:

- Menubar:** Located at the top left, containing menu items like File, Edit, View, Window, and Help.
- Toolbar:** A row of icons for various editing and navigation functions.
- Modebar:** A vertical bar on the left side with icons for different editing modes.
- Model Editing Windows:** The main workspace showing a hierarchical model. The top window, titled "System", shows a flow from "PreProcessing" to "Processing" to "PostProcessing". The "Processing" window is open, showing a detailed view of the "Processing" component with inputs "In" and outputs "Time" and "Freq".
- Model Browser:** A tree view on the right side showing the project structure, including folders like "System", "PostProcessing", "PreProcessing", "Processing", and "Branch0".
- Partbrowser:** A panel at the bottom left showing available components: "CompoundParts", "InputSignals", "OutputSignals", and "PrimitiveParts".
- Attribute Browser:** A panel on the bottom right showing properties for the selected "Branch0" component, including "Firing" (IFALL), "Script" (ComputeTime), and "Priority" (10).
- Statusbar:** Located at the bottom, showing the current state as "Ready" and the window title "EDIT | 100% | SF2000 | 11:39 AM".

GME: Modeling based on previously defined Metamodel



GME: OCL Constraint Validation

T Name: SF2000 | ParadigmSheet | Aspect: Constraints | Base: N/A

```

classDiagram
    class Folder["Folder <<Folder>>"]
    class Processing["Processing <<Model>>"]
    class Primitive["Primitive <<Model>>"]
    class Compound["Compound <<Model>>"]
    class Signal["Signal <<Atom>>"]
    class InputSignal["InputSignal <<Atom>>"]
    class OutputSignal["OutputSignal <<Atom>>"]
    class DataflowConn["DataflowConn <<Connection>>"]
    class ParameterConn["ParameterConn <<Connection>>"]

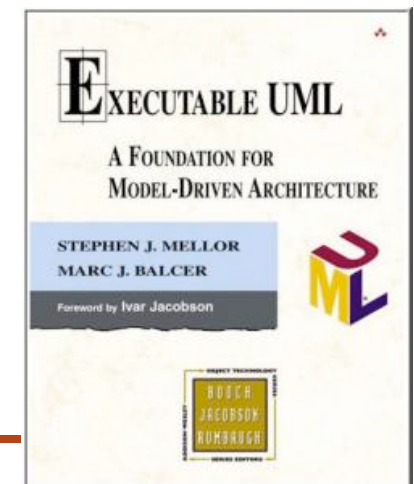
    Folder <|-- Processing
    Processing <|-- Primitive
    Processing <|-- Compound
    Signal <|-- InputSignal
    Signal <|-- OutputSignal
  
```

AtLeastOnePart for Kind

Attributes	Preferences	Properties
Description:	Compounds must have parts	
Default parameters:		
Equation:	self.parts()->size > 0	
Priority (1=High):	2	
Depth:	1	
On close model	False	
On create	False	
On delete	False	
On new child	False	
On lost child	False	
On move	False	
On derive	False	
On connect	False	
On disconnect	False	
On change attribute	False	
On change property	False	
On change assoc.	False	
On refer	False	
On unrefer	False	
On include in set	False	
On exclude from set	False	

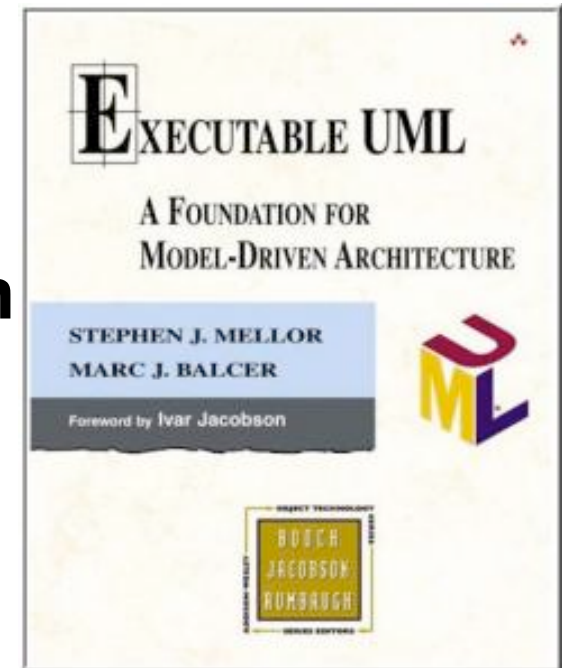
Executable UML (xUML) Concepts

- Executable UML is not a formal standard, but a goal for a UML-based programming language
- Must eliminate redundancy and ambiguities, to increase executability of UML
- Action language needed to define complete implementations of software systems
- Not a DSL, but rather a universal, UML-based programming language



Executable UML → Action Semantics

- Hard to model a complete system today via UML or even MOF-based languages
- Action semantics do not contain structural constructs (classes, attributes & relationships)
 - Already defined in the structural part of the model
 - Merely define behavioral building blocks

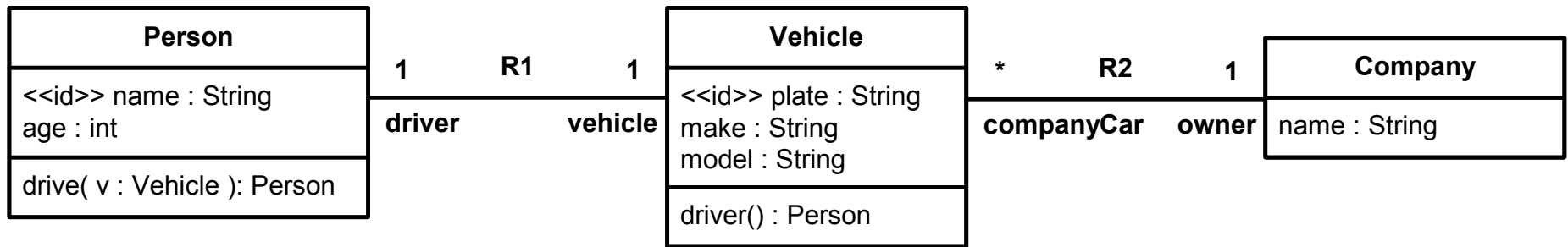




Action Semantics in UML 2.0

- Models **procedural behavior** via abstract syntax
- **Variables** for assigning/reading (sets, bags...)
- Arithmetic and logical operations
- Control flow (if-then-else, case, block...)
- Class extents that be queried (SQL-like)
- Creation, deletion, and navigation of associations
- Generation of signals and timers
- Definition of functions

Action Languages Example 1/3



```
myJeep = create Vehicle with plate = "IYQ2"  
myJeep.make = "Chrysler Jeep"  
myJeep.model = "Liberty CRD"
```




Action Languages Example 2/3

```
shawn = create Person with name = "Shawn"
```

We can now call the operation drive() to let the driver drive the vehicle.

```
[actualDriver] = drive[aVehicle] on shawn
```

What is still missing, of course, is the implementation of the operation drive(). The least it must do is to instantiate the association R1 (that is, to create a link between the two concerned objects).

```
link this R1 aVehicle
```



Action Languages Example 3/3

```
theCurrentDriver = this.R1.“driver“
```

Let's assume we want to find all people in the system:

```
{allPersons} = find-all Person
```

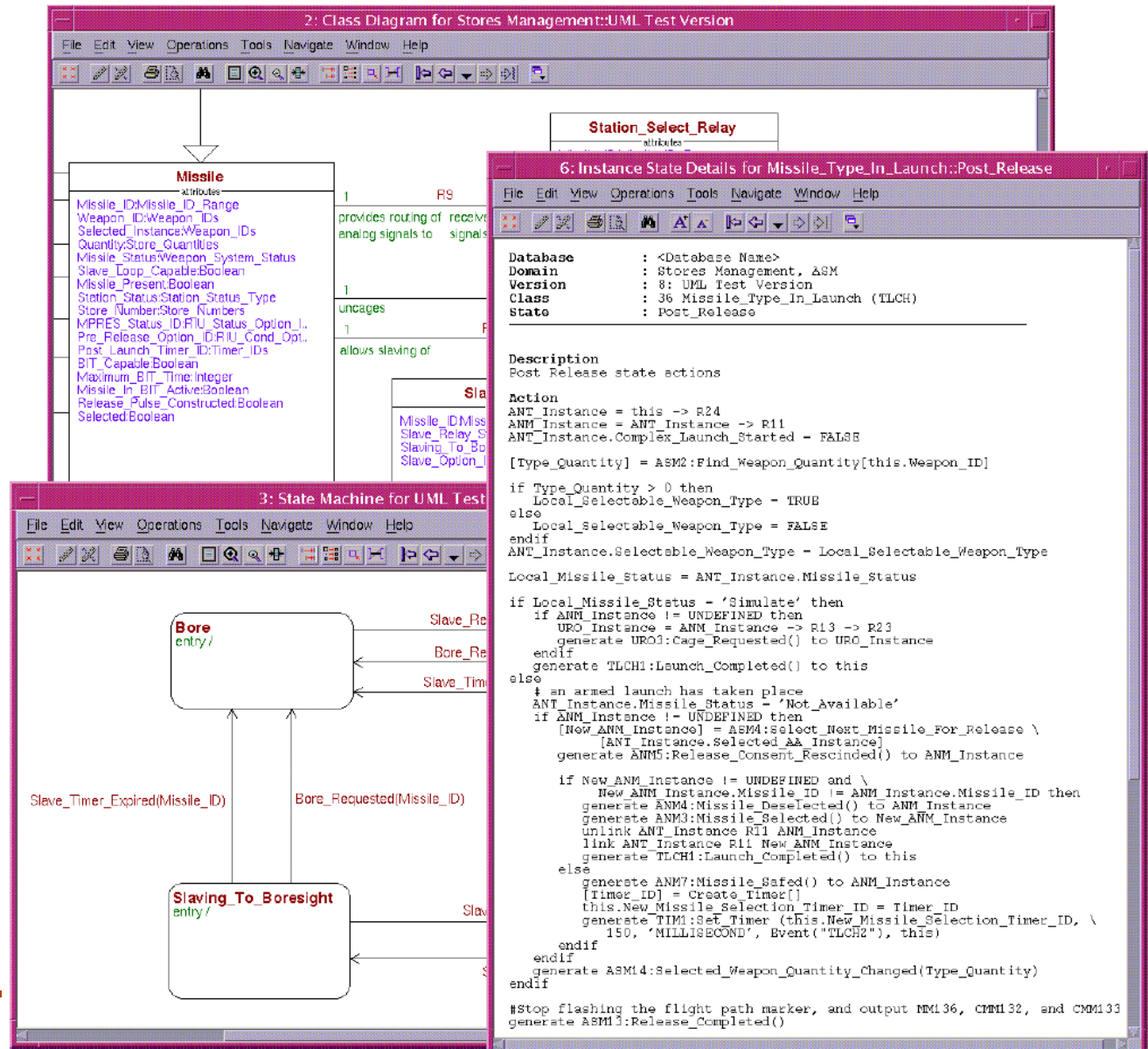
The braces state that allPersons is a set of objects instead of just one.

One can also limit such a search. For example, all vehicles of the brand Jeep can be looked for.

```
{Jeeps} = find Vehicle where make = “Jeep”
```

Example: Kennedy Carter's iUML

- Model Diagrams
- Code
- Integration



Recipe Framework for Integrating Manually Developed Code

The screenshot illustrates the Recipe Framework integration process in an IDE. The Package Explorer on the left shows the project structure, including folders like `>example`, `>BC1.impl`, `>BC2.impl`, `>tests`, `>src-gen`, `>BC1`, `>impl`, `>CannotAdd.java`, `>IC1.java`, `>ICalculator.java`, `>BC2`, `>exsys.client`, `model`, `build.properties`, `build.xml`, `>dump.dump`, and `>helloWorld.recipes`. The Ant console at the bottom shows build tasks such as `oAW - antlrInstantiator - build`, `oAW - antSupport - build`, `oAW - core - build`, `oAW - metamodelGenerator - build`, `oAW - recipe.ant - build`, `oAW - recipe.core - build`, `oAW - recipe.plugin - update`, `oAW - recipe.simpleChecks - build`, and `oAW - umlMetamodel - 1) generate`.

The main editor displays a recipe file with annotations 1-7. The Recipes view on the right shows a table of recipe properties and their values:

Name	Value
<code>_type</code>	<code>org.open</code>
<code>_type</code>	<code>org.open</code>
<code>className</code>	<code>example.BC1.impl.C1Implementation</code>
<code>element</code>	<code>:example:BC1:C1</code>
<code>projectName</code>	<code>scmHelloWorld</code>
<code>srcPath</code>	<code>src</code>

Annotations in the recipe file include:

- 1: `build.xml`
- 2: `you have to provide an implementation class.`
- 3: `the implementation class has to extend the generated componen`
- 4: `example.BC1:C1`
- 5: `the generator generates a base class for components, in this case example.BC1.impl.C1ImplementationBase. From this base class you have to extend your own class that has to be called example.BC1.impl.C1Implementation`
- 6: `>BC1.impl`
- 7: `>impl`



Homework and Milestone Reminders

- **Milestone 3/4: Final MBSE Environment (see Milestone 3/4 assignments)**
 - Due by 11:55pm, Friday, May 13th, 2011.

- **Term Paper and Presentation**
 - Paper Due by 11:55pm, Tuesday, May 17th, 2011.
 - Presentation Due by 1:35pm, Thursday, May 19th, 2011.