Aspects of the **UML**

**Dynamic Modelling**
- Object Interactions
- System Dynamics
- Models

**Modelling Behaviour**

Describing Behaviour

- **Dynamic Modelling**
  - **UML State Diagram**
  - **UML Sequence Diagram**
  - **UML Collaboration Diagram**
  - **UML Activity Diagram**

State Diagram

- Each Class may have an optional associated State Diagram.
- Developed by Harel.
- Incorporated into OO methods by Rumbaugh (OMT) and many others.

Notation

- State 1
- Event[guard]/action
- Name of event which causes transition
- Must be true for event to fire.
- Action performed when event occurs

Example

- Pop-up menu control
  - idle
  - right button down/display
  - menu visible
  - right button up/erase
  - Cursor Moved/Highlight item
**Activity**

- An activity is an operation that takes time to complete. Activities are associated with states.

**Action**

- An action is an instantaneous operation associated with an event.
- Semantics of instantaneous is ambiguous.

**General Notation**

- Event may have optional attributes associated (event supplies data)
- Optional guard conditions (pre-conditions) must be satisfied before a transition occurs.

**Message Notation**

- Synchronous: blocking call.
- Asynchronous: non blocking call
- Simple: no details about communication.
- Synchronous with immediate return.

**Nesting State Diagrams**

- State diagrams for an Object may be nested, allowing the control mechanism to be viewed at different levels.
**Example: Dispense Item**

- `do/ move arm to correct row`
- `arm ready`
- `do/ move arm to correct col`
- `do/ push off shelf`
- `arm ready`
- `pushed`

**Example: Select Item**

- `do/ reset item`
- `clear`
- `enter`
- `digit(n)`
- `select(item)`

**Generalisation of States**

- Groups of substates with common transitions can be combined into a single superstate, and inherit transitions from the superstate.

**Example: Transmission**

- `Transmission`
- `push R`
- `Neutral`
- `push F`
- `push N`
- `Forward`
  - `1st`
  - `downshift`
  - `stop`
  - `upshift`
  - `2nd`
  - `downshift`
  - `upshift`
  - `3rd`

**Example: Generalisation**

- **Forward** is an abstract state.
- Selecting **N** in any forward gear will cause a transition to **Neutral**.
- Selecting **Stop** in any forward gear will cause a transition to **First**.

**Example: Object Model**

- `Car`
- `Ignition`
- `Transmission`
- `Brake`
- `Accelerator`
Dynamic Model

- Ignition state diagram
- Transmission state diagram
- Accelerator state diagram
- Brake state diagram

Dynamic Model: Ignition

- Ignition turn key (transmission in Neutral)
- Ignition turn key off
- Ignition release key

Dynamic Model: Transmission

- Transmission
- Forward
  - 1st
  - 2nd
  - 3rd
- Push R
- Push N
- Push F
- Reverse
- Neutral

Dynamic Model: Accelerator & Brake

- Accelerator
  - Press acc
  - Rel acc
  - Off
  - On
- Brake
  - Press brake
  - Rel brake
  - Off
  - On

Concurrency

- Aggregation concurrency: The aggregate state corresponds to the combined states of all the components.

Concurrency (cont..)

- Concurrency within an Object:
  Concurrency within the state of a single Object arises when an object can be partitioned into subsets of attributes or links, each of which has its own state diagram.
Concurrency (cont..)

Example: Programmable Thermostat

Links to the Class Diagram
- Keep SD as simple as possible.
- Events, actions, activities must each map directly to functions on the UML Class Diagram.
- A “dictionary” of all functions and data is maintained for consistency across all diagrams and models.

Class and State Diagrams
- If a function appears on a State Diagram, then it must appear on a corresponding Class Diagram, otherwise there is no rigor.
- CASE tools like Rational Rose help support this rigor by assisting modeller with lists of operations and generating reports of orphan operations (not on Class diagram).

OO Method Adaptations
- ROOM
- Octopus
- INSYDE’s OMT*
  - http://www.comppapp.dcu.ie/~bstone/research
- Catalysis
  - http://www.iconcomp.com
- Rational’s Process (Objectory)
  - http://www.rational.com

UML Tools
- At present there are two main UML tool vendors...
  - Rational: the Rose CASE tool
    - http://www.rational.com
  - Object Team: the Cayenne CASE tool
    - http://www.objectteam.com
Graded Exercise

This is the final exercise. Well worth doing!!!

An ATM case-study is defined on the public directory.

- Develop a Class Diagram for the ATM
- Develop a State Diagram for performing a Query on Account.
- Use Rational Rose.

Hints: Make "Transaction" a class. "Query" is a type-of "Transaction" (inherited from).

Partial Telecomms example available on public directory for reference.