**Data Flow Diagrams**

**Structured Analysis**
- Models data elements
  - Attributes
  - Relationships
- Models processes that transform data

**Modeling Tools**
- Data object diagrams
- ERD diagrams
- Data flow diagram
- Process narrative

A data flow diagram describes information flow among a set of processes and actors. A process narrative describes how a single process transforms input data to output data.

**DFDs and Progressive Refinement**

Each DFD reveals progressively more detail than the DFD that preceded it.

**Level 1 DFD:**

- Control panel
- Interact with user
- Configure system
- Configure request
- Start/Stop request
- Activate/deactivate system
- Process password

Refinement continues until each bubble can be (easily) implemented as a program module.
A process specification describes all of the flow processes in the final (most detailed) DFD.

"The process password transform performs password validation at the control panel for the SafeHome security function. Process password receives a four-digit password from the interact with user function. The password is first compared to the master password stored within the system ..."

A process specification can be represented as a collection of process narratives.

Some Guidelines

- Level 0 DFD must contain only a single bubble
- All arrows and bubbles should be meaningfully labeled
- Refinement begins by isolating next level processes, data objects, and data stores
- Refine only one bubble at a time
- Data flow continuity must be maintained between levels

Exercise: Data Flow Diagrams

Create a level 0 data flow diagram for a basic automated teller machine (ATM).

You can ignore administrative scenarios.

What would the level 1 data flow diagram look like?
A Different View

Object-Oriented Analysis
- Models analysis classes
  - Data
  - Processes
- Models class collaborations

Modeling Tools
- Class diagrams
- Packages
- CRC cards
- Sequence diagrams

Object-oriented analysis results in an analysis model that describes a system of collaborating objects.

Every object *encapsulates* a set of data elements, and *exports* a set of operations for working with those elements.

CRC Cards

- **Class-responsibility-collaborator** (CRC) cards provide a way to organize a system’s classes:
  - Each class is represented by an index card that identifies:
    - The class
      - Just a simple name
    - Its responsibilities
      - Description of attributes and operations
    - Its collaborators
      - Other classes that help satisfy responsibilities

CRC Cards: Example

<table>
<thead>
<tr>
<th>Class: FloorPlan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description: The FloorPlan class ...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsibilities:</th>
<th>Collaborators:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defines floor plan name/type</td>
<td>Wall, Door, Window</td>
</tr>
<tr>
<td>Manages floor plan positioning</td>
<td></td>
</tr>
<tr>
<td>Scales floor plan for display</td>
<td></td>
</tr>
<tr>
<td>Incorporates walls, doors, and windows</td>
<td></td>
</tr>
<tr>
<td>Shows position of video cam</td>
<td>Camera</td>
</tr>
</tbody>
</table>

Model Validation with CRC Cards

- A CRC model can be validated by the project team using the following procedure:
  - All participants are given a set of CRC cards
  - Cards that collaborate should be separated
  - Each use-case is read by the facilitator
    - When a named class is reached, a token is passed to the person holding the corresponding CRC card
  - The token holder reads the responsibilities on their card
    - The team determines whether the class’s responsibilities satisfy the use-case
    - Card responsibilities and collaborations are validated
  - Responsibilities and collaborations are updated
UML Sequence Diagrams

- CRC cards provide one way to model collaborations
  - Easy to develop and maintain
  - Easy for stakeholders to understand
  - High-level view of responsibilities and interactions
  - Acid-test validation
- **UML sequence diagrams** provide an alternative view, focusing on method interactions
  - More difficult to develop and maintain
  - Not always easy for stakeholders to understand
  - More detailed view of interactions
  - More detailed validation

Sequence Diagram Exercise