## Structured Paradigm Design Phase

- Input to design process is the specification document
  - Description of what the product must do
- The output from design process is the design document
  - Description of how the product is to achieve its goal



## Structured Paradigm Design Phase

- Software design phase consists of three activities
  - Architectural design
    - General, Logic, or High-Level design
      - Analyze specification
      - Module structure is produced
  - Detailed design
    - Modular, Physical, or Low-Level design
      - Each module is designed in detail
  - Design testing

## Structured Paradigm Design Phase

- Two basic ways of designing products in structured paradigm:
  - Action-Oriented design
  - Data-Oriented design



## Structured Paradigm Design Phase

- Action-Oriented design
    - Objective is to design modules with high cohesion
  - Weaknesses
    - Concentration on action
    - Data is secondary

## Structured Paradigm Design Phase

- Data-Oriented design
    - Structure of the data is determined
    - Procedures are designed to conform to the structure of data
  - Weaknesses
    - Concentration on data
    - Action is secondary



## Solution To Structured Paradigm

- The solutions to these problems are
  - Object-Oriented technique
    - Equal weight to both
      - Data
      - Action

# Action-Oriented Design

- Decomposing a product into modules with
  - High cohesion
  - Low coupling
- Two practical techniques to achieve this goal
  - Data flow analysis
  - Transaction analysis

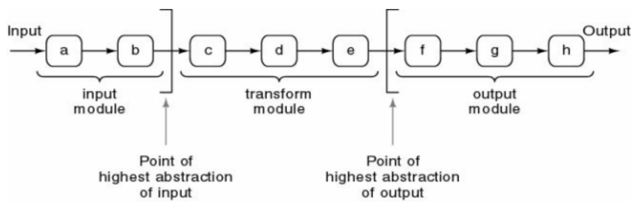


# Data Flow Analysis

- Technique for achieving modules with high cohesion
- Once the Data Flow Diagram is completed, the designer has precise and complete info regarding input to and output from the product
- Modules are decomposed stepwise until each module performs a single task

# Data Flow Analysis

- DFA is a way to achieve high cohesion not low coupling
- In order to achieve low coupling, minor modifications to the design are needed






# Transaction Analysis

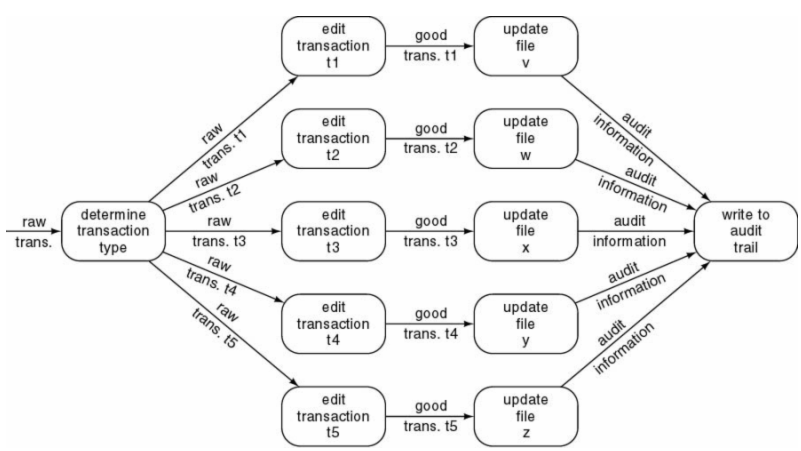
- Transaction is an operation
  - Process request
  - Print a list of today's orders
  - Example
    - Software controlling an Automated Teller Machine

# Transaction Analysis

- Design strategy is to brake down the product into two pieces
  - The analyzer
    - Determines the transaction type
    - Passes the information to the dispatcher
  - The Dispatcher
    - Performs the transaction



# Transaction Analysis



# Data-Oriented Design

- Basic idea is to:
  - Create the data structure
  - Design the product around the data structure
  - Each procedure is given the data structure as input on which it will operate
- After Object-Oriented paradigm it lost popularity





# Object-Oriented Design

- The goal is to design the product in terms of Objects
  - Instance of classes
- OOD can be used for products utilizing
  - C
  - FORTRAN
  - COBAL
- It is not an easy task but possible

# Object-Oriented Design

- OOD consist of four steps
  - Construct interaction diagrams for each scenario
  - Construct the detailed class diagram
  - Design the product in terms of client of Objects
  - Proceed to the detailed design





# OOD-First Step

- UML supports two types of diagrams
  - Sequence diagram
    - Emphasizes the explicit sequence of messages
    - Important when the order of events and messages are critical
  - Collaboration diagram
    - Emphasizes the relationship between objects
    - Powerful tool in understanding the structure of product
  - Both diagrams show the same thing in different way

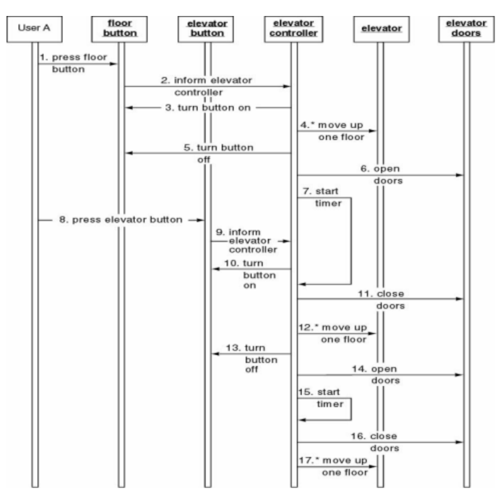
# OOD-First Step

1. User A presses the Up floor button at floor 3 to request an elevator. User A wishes to go to floor 7.
2. The floor button informs the elevator controller that the floor button has been pushed.
3. The elevator controller sends a message to the Up floor button to turn itself on.
4. The elevator controller sends a series of messages to the elevator to move itself up to floor 3. The elevator contains User B, who has entered the elevator at floor 1 and pressed the elevator button for floor 9.
5. The elevator controller sends a message to the Up floor button to turn itself off.
6. The elevator controller sends a message to the elevator doors to open themselves.
7. The elevator control starts the timer.
   User A enters the elevator.
8. User A presses elevator button for floor 7.
9. The elevator button informs the elevator controller that the elevator button has been pushed.
10. The elevator controller sends a message to the elevator button for floor 7 to turn itself on.
11. The elevator controller sends a message to the elevator doors to close themselves after a timeout.
12. The elevator controller sends a series of messages to the elevator to move itself up to floor 7.
13. The elevator controller sends a message to the elevator button for floor 7 to turn itself off.
14. The elevator controller sends a message to the elevator doors to open themselves to allow User A to exit from the elevator.
15. The elevator controller starts the timer.
    User A exits from the elevator.
16. The elevator controller sends a message to the elevator doors to close themselves after a timeout.
17. The elevator controller sends a series of messages to the elevator to move itself up to floor 9 with User B.

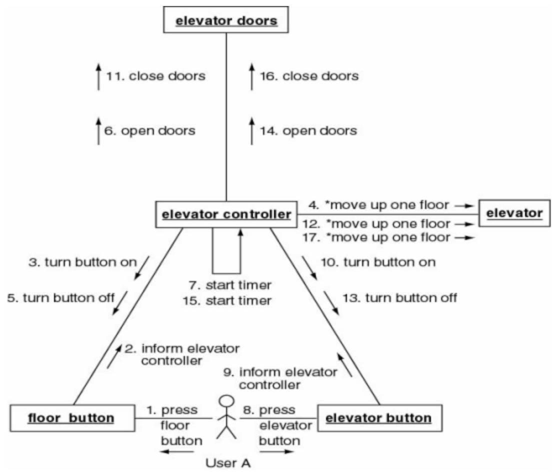




# OOD-First Step



# OOD-First Step






# OOD-Second Step

- Methods are inserted into class diagram (from OOA)
  - Examine all interaction diagrams
    - Easy to do
  - Figure out which action should be associated with each class
    - Difficult to do

# OOD-Second Step

- An action can be assigned to
  - Class
    - Program unit that accepts a message
  - Client
    - Program unit that sends a message

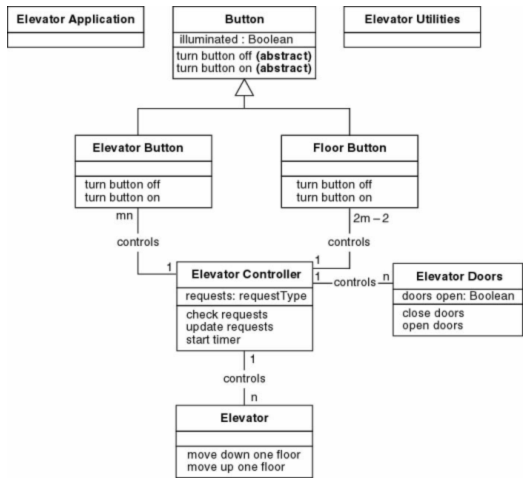




# OOD-Second Step

- Ways to decide how to assign actions
  - Based on information hiding
    - State variable and the actions performed should be assigned to that class
  - Based on popularity
    - If an action is being invoked by many clients of an object, the action should be assigned to that object
  - Based on responsibility
    - The client should not know how an action is being performed

# OOD-Second Step

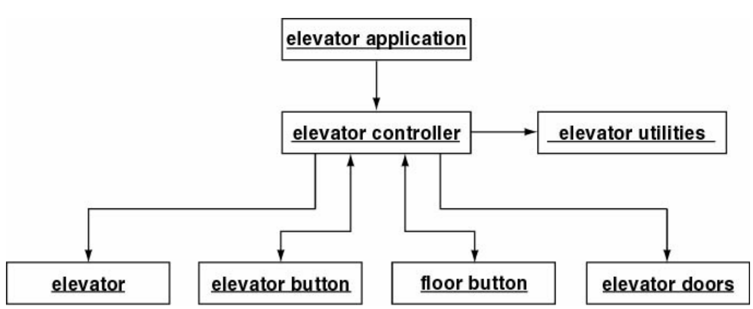







# OOD-Third Step

- Interaction diagram is to show client of each object



## OOD-Fourth Step

- Detailed design is developed for all classes
  - Pseudocode



## Real-Time Design Techniques

- Real-Time software is characterized by hard time limits
- If the time constraint is not met the data is lost
- Real-Time systems are implemented on a distributed system
- Examples
  - Computer controlled nuclear power plant
  - Software controlling a fighter aircraft

## Testing During The Design Phase

- The goal of testing is
  - Verify all items in specification have been implemented accurately and completely
  - Verify the design
    - logic does not contain faults
    - Interfaces have been defined correctly
- Important to correct all faults before coding



## Testing During The Design Phase

- Design faults can be detected by
  - Design inspection
  - Design walkthroughs

## Metrics For The Design Phase

- Keeping track of
  - Number of modules
  - Module cohesion and coupling are measured for quality of design
  - Fault statistics
  - Number and type of faults discovered during inspection or walkthrough





## Challenges Of The Design Phase

- Design team can go wrong in two ways
  - By doing too much
    - Designers who enjoy coding, write modules in C++ or JAVA instead of pseudocode
  - By doing too little
    - Leave the majority of the detail design to programmer
- Insuring that all interfaces are correct is the primary reason for detail design