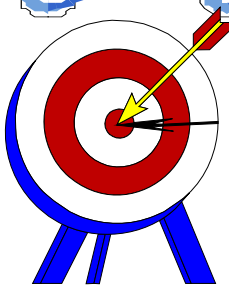
Object-Oriented Systems Development:
Using the Unified Modeling Language

Chapter 4:
Object-Oriented Methodologies



Goals

- **Object-Oriented Methodologies**
  - **The Rumbaugh et al. OMT**
  - **The Booch methodology**
  - **Jacobson's methodologies**

Goals (Con't)

- **Patterns**
- **Frameworks**
- **Unified Approach (UA)**
- **layered Architecture**

Basic Definitions

- **A methodology is explained as the science of methods.**
- **A method is a set of procedures in which a specific goal is approached step by step.**

Too Many Methodologies

- **1986: Booch came up with the object-oriented design concept, the Booch method.**
- **1987: Sally Shlaer and Steve Mellor came up with the concept of the recursive design approach.**

Too Many Methodologies (Con't)

- **1989: Beck and Cunningham came up with class-responsibility-collaboration (CRC) cards.**
- **1990: Wirfs-Brock, Wilkerson, and Wiener came up with responsibility-driven design.**
- **1991: Peter Coad and Ed Yourdon developed the Coad lightweight and prototype-oriented approach.**

Too Many Methodologies (Con't)

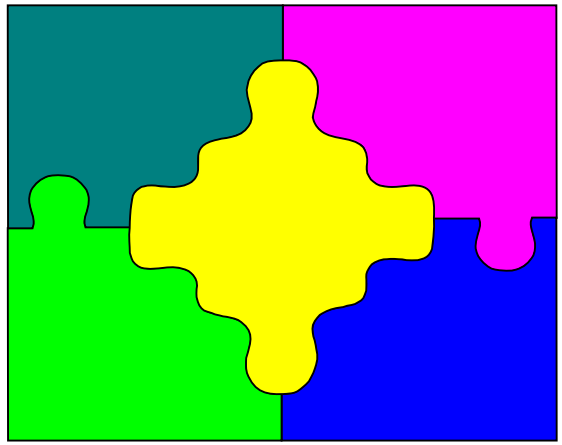
- **1991: Jim Rumbaugh led a team at the research labs of General Electric to develop the object modeling technique (OMT).**
- **1994: Ivar Jacobson introduced the concept of the use case.**

Survey of Some of the Object-Oriented Methodologies

- **Many methodologies are available to choose from for system development.**
- **Here, we look at the methodologies developed by Rumbaugh et al., Booch, and Jacobson which are the origins of the Unified Modeling Language (UML) and the bases of the UA.**

Rumbaugh et. al.'s Object Modeling Technique (OMT)

- **OMT describes a method for the analysis, design, and implementation of a system using an object-oriented technique.**



OMT (Con't)

- **OMT consists of four phases, which can be performed iteratively:**
  - **1. *Analysis*. The results are objects and dynamic and functional models.**
  - **2. *System design*. The result is a structure of the basic architecture of the system.**

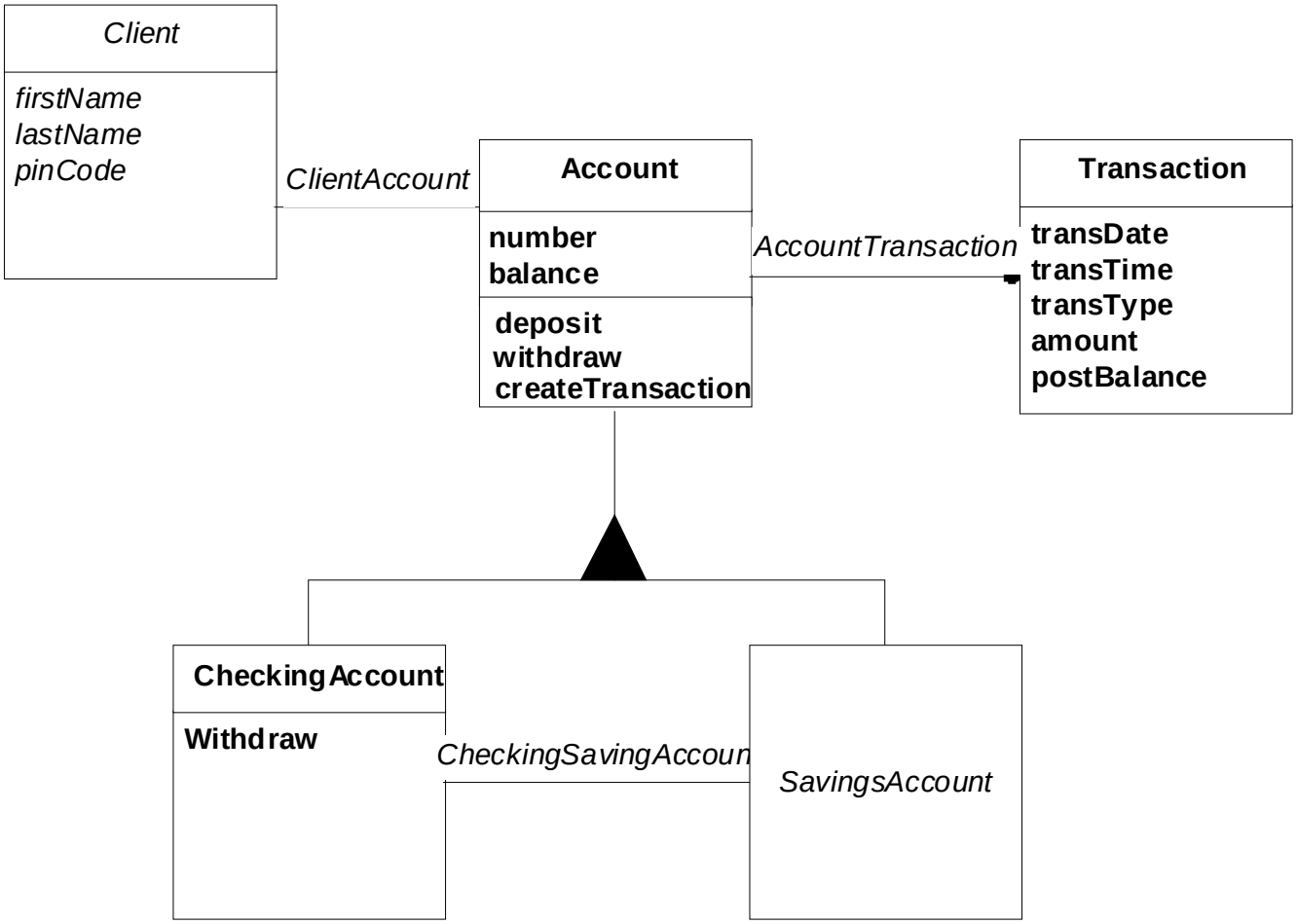
OMT (Con't)

- **3. *Object design*. This phase produces a design document, consisting of detailed objects and dynamic and functional models.**
- **4. *Implementation*. This activity produces reusable, extendible, and robust code.**

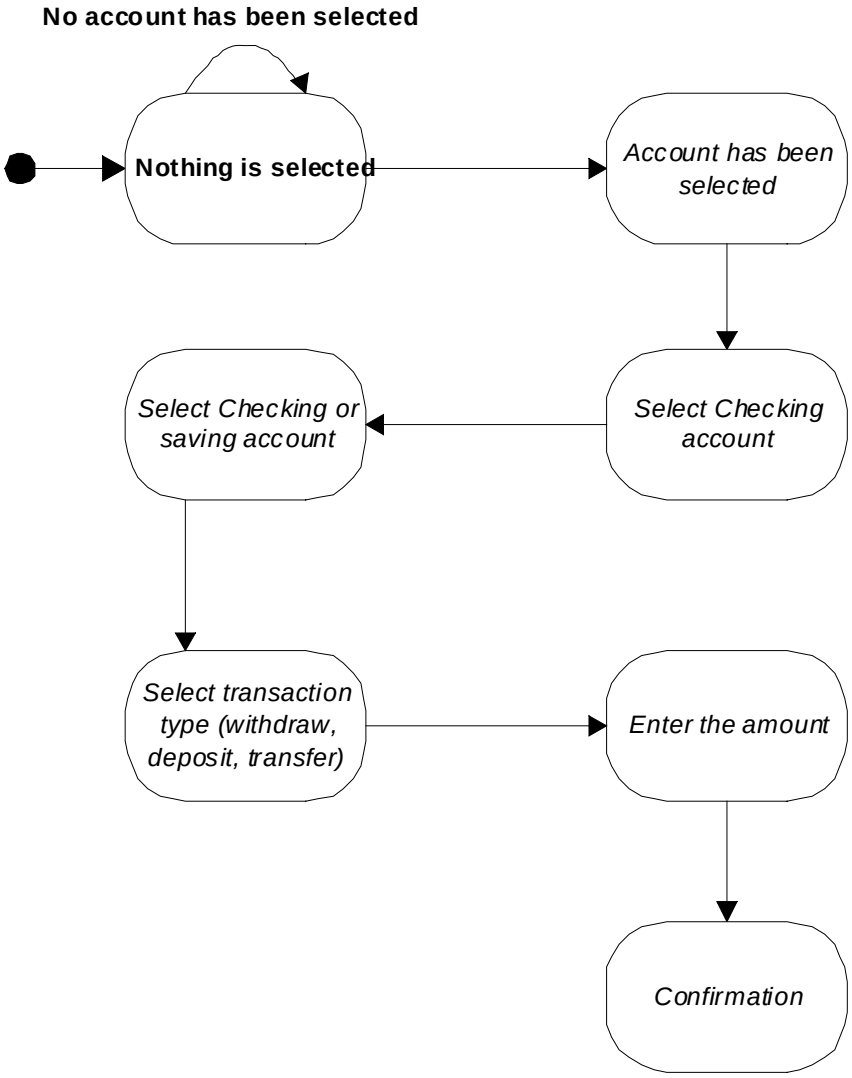
OMT Modeling

- **OMT separates modeling into three different parts:**
  - **1. An *object model*, presented by the object model and the data dictionary.**
  - **2. A *dynamic model*, presented by the state diagrams and event flow diagrams.**
  - **3. A *functional model*, presented by data flow and constraints.**

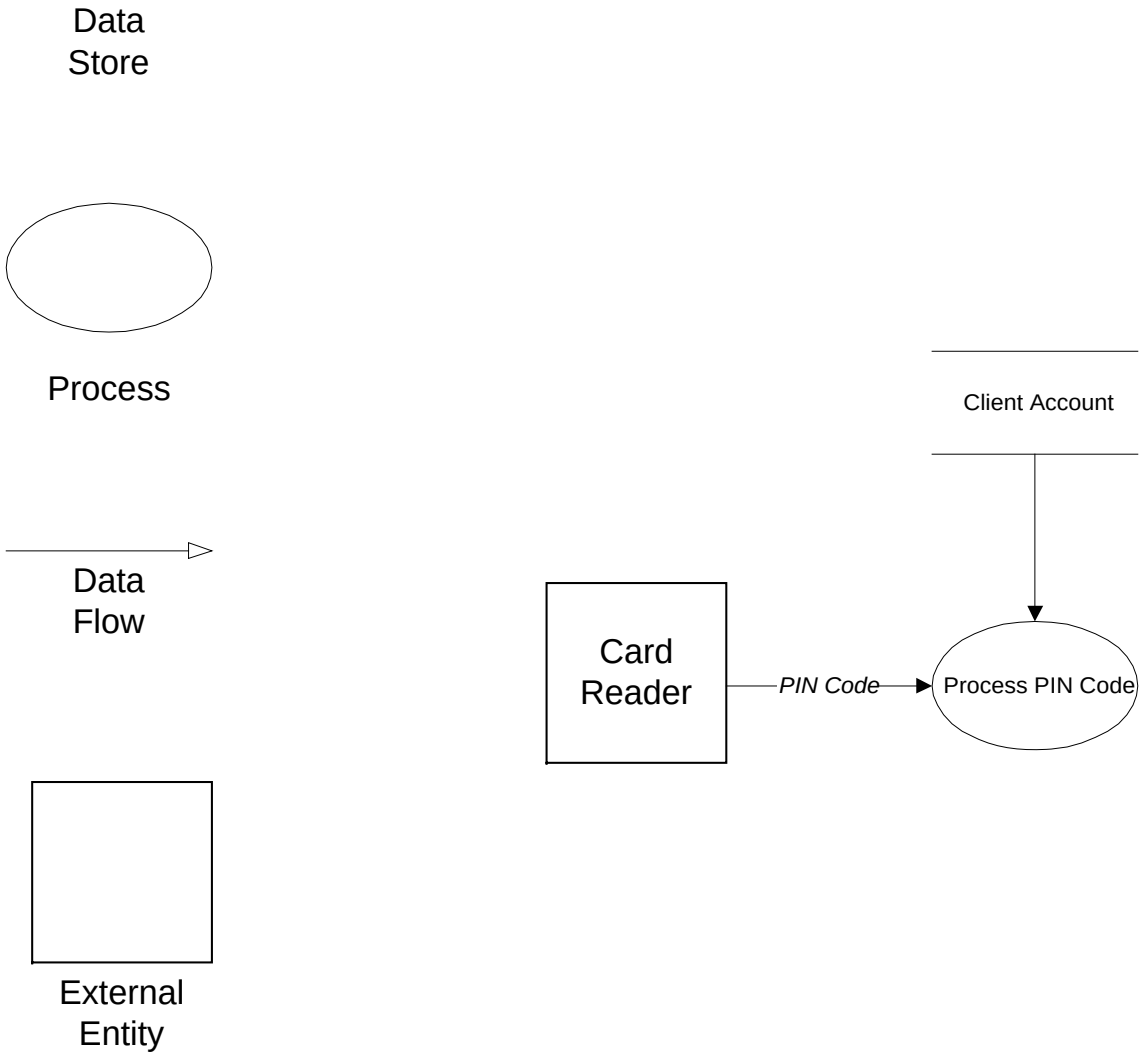
OMT Object Model



OMT Dynamic Model

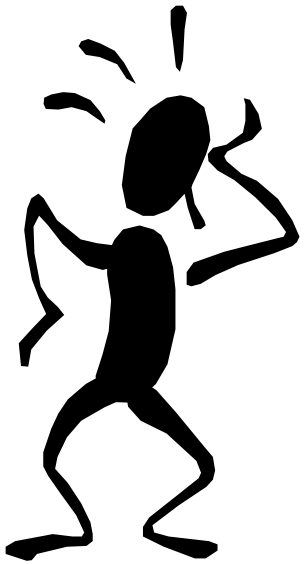


OMT Functional Model



The Booch Methodology

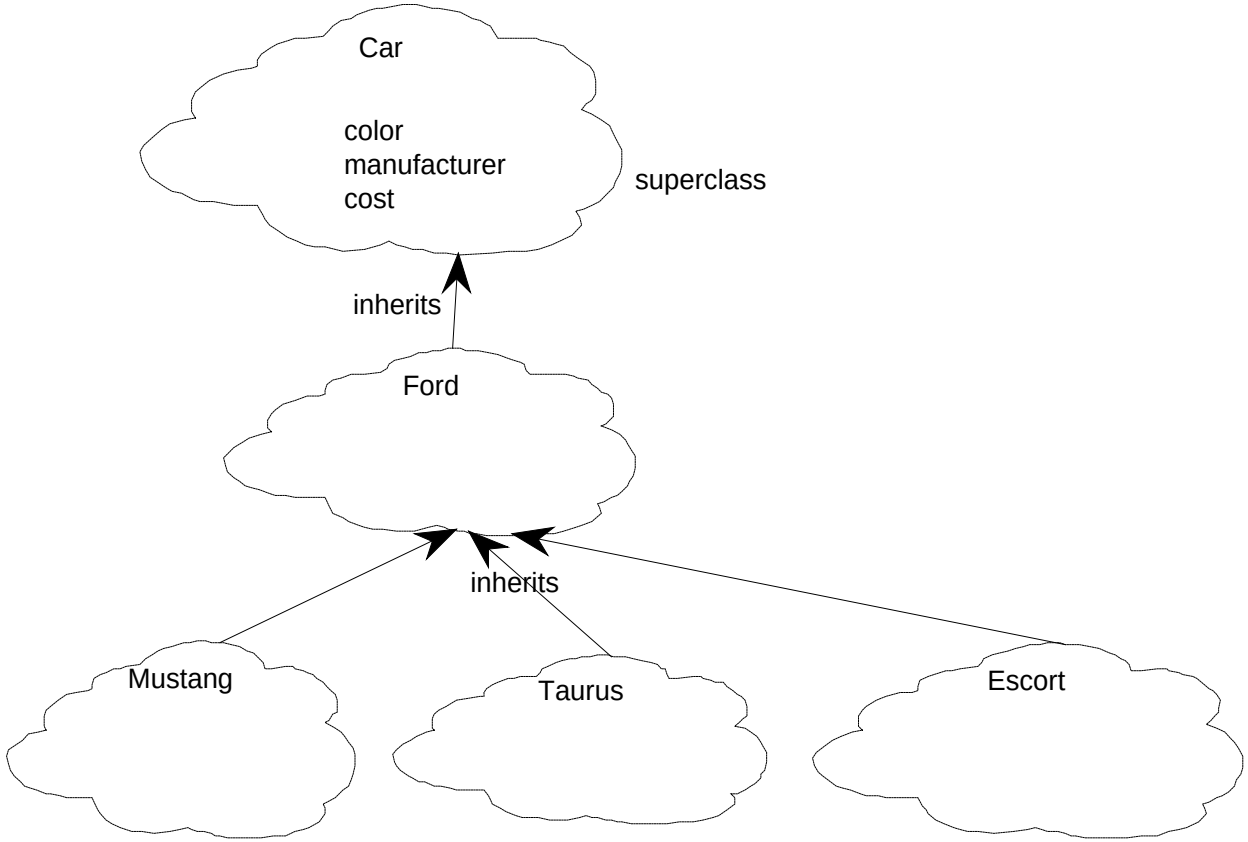
- **The Booch methodology covers the analysis and design phases of systems development.**
- **Booch sometimes is criticized for his large set of symbols.**



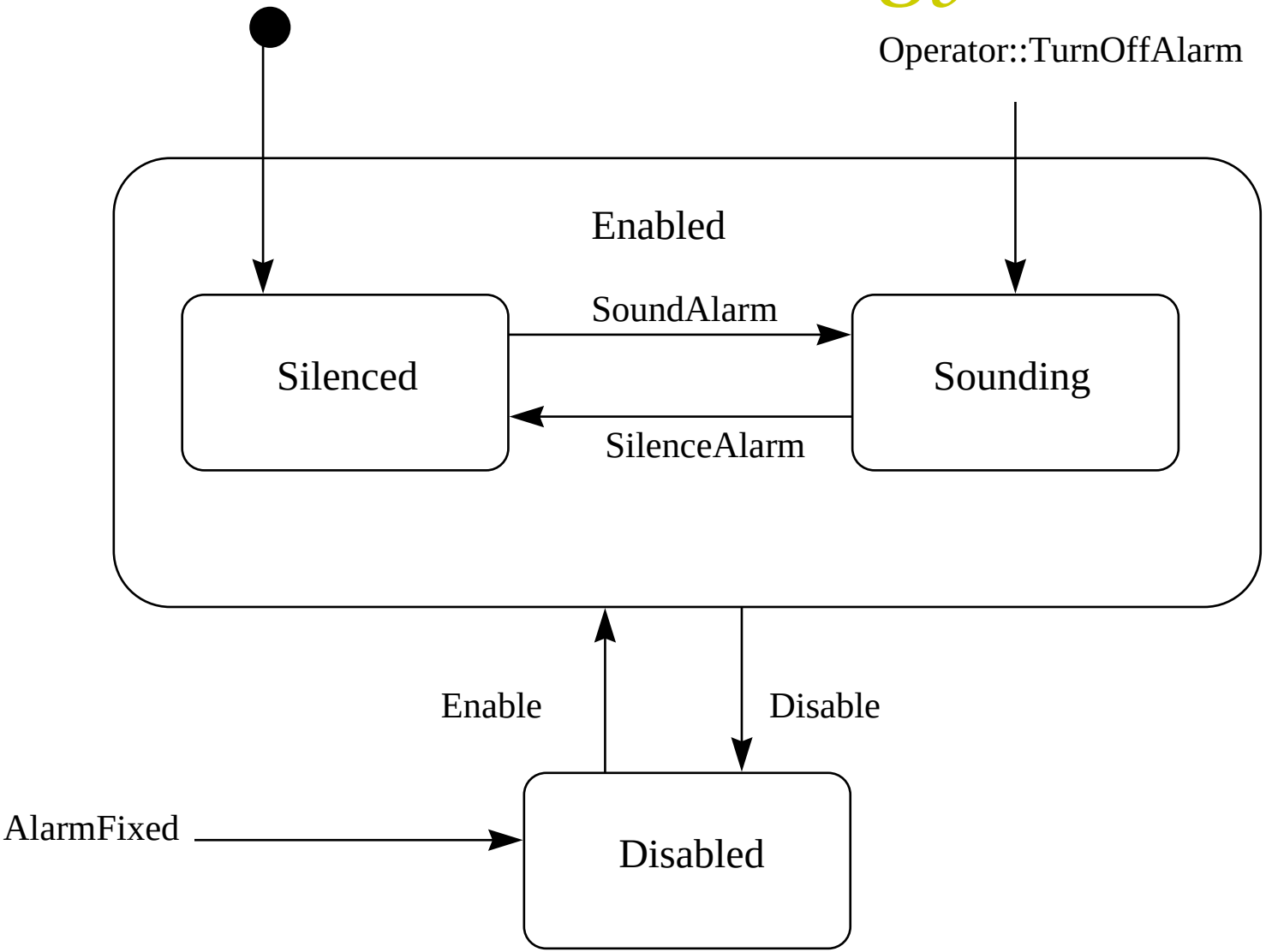
The Booch Methodology (Con't)

- **The Booch method consists of the following diagrams:**
  - *Class diagrams*
  - *Object diagrams*
  - *State transition diagrams*
  - *Module diagrams*
  - *Process diagrams*
  - *Interaction diagrams*

The Booch Methodology (Con't)

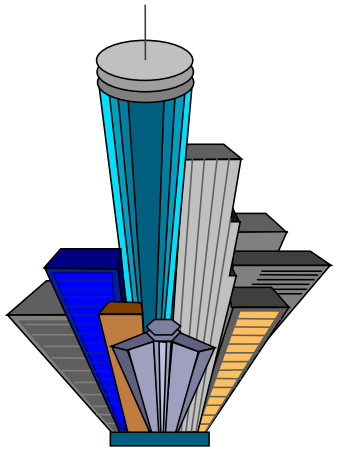


The Booch Methodology (Con't)



The Booch Methodology (Con't)

- **The Booch methodology prescribes**
  - *A macro development process*
  - *A micro development process.*



The Macro Development Process

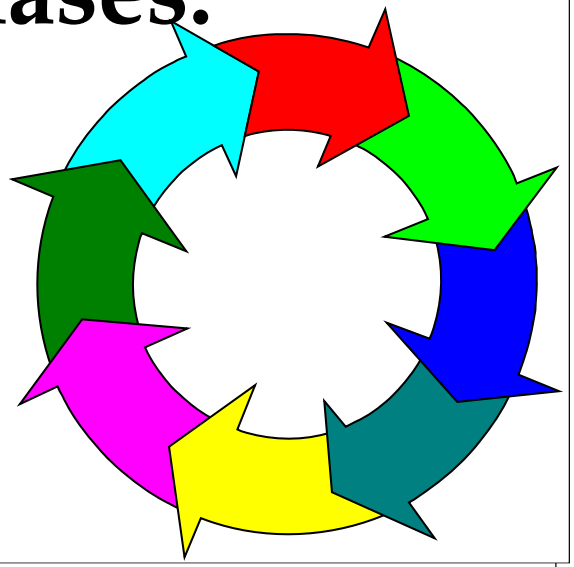
- **The macro development process consists of the following steps:**
  - *1. Conceptualization*
  - *2. Analysis and development of the model.*
  - *3. Design or create the system architecture.*
  - *4. Evolution or implementation.*
  - *5. Maintenance.*

The Micro Development Process

- **The micro development process consists of the following steps:**
  - *1. Identify classes and objects.*
  - *2. Identify class and object semantics.*
  - *3. Identify class and object relationships.*
  - *4. Identify class and object interfaces and implementation.*

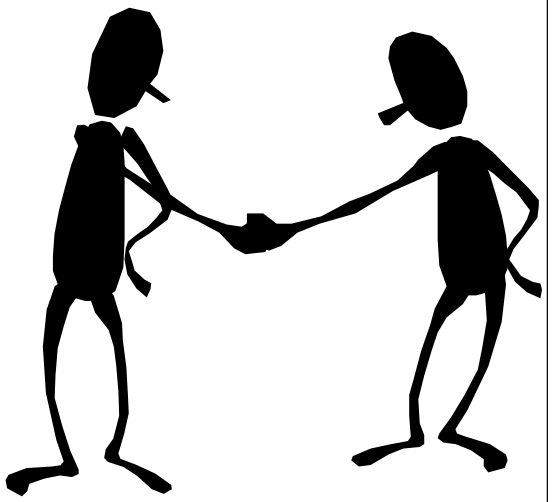
The Jacobson et al. Methodologies

- **The Jacobson et al. methodologies (e.g., OOBE, OOSE, and Objectory) cover the entire life cycle and stress traceability between the different phases.**



Use Cases

- **Use cases are scenarios for understanding system requirements.**
- **A use case is an interaction between users and a system.**
- **The use-case model captures the goal of the user and the responsibility of the system to its users.**

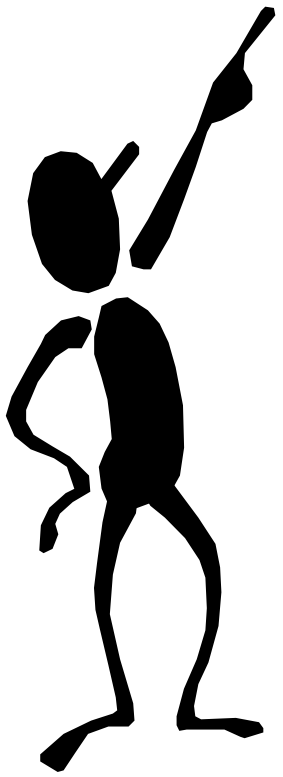


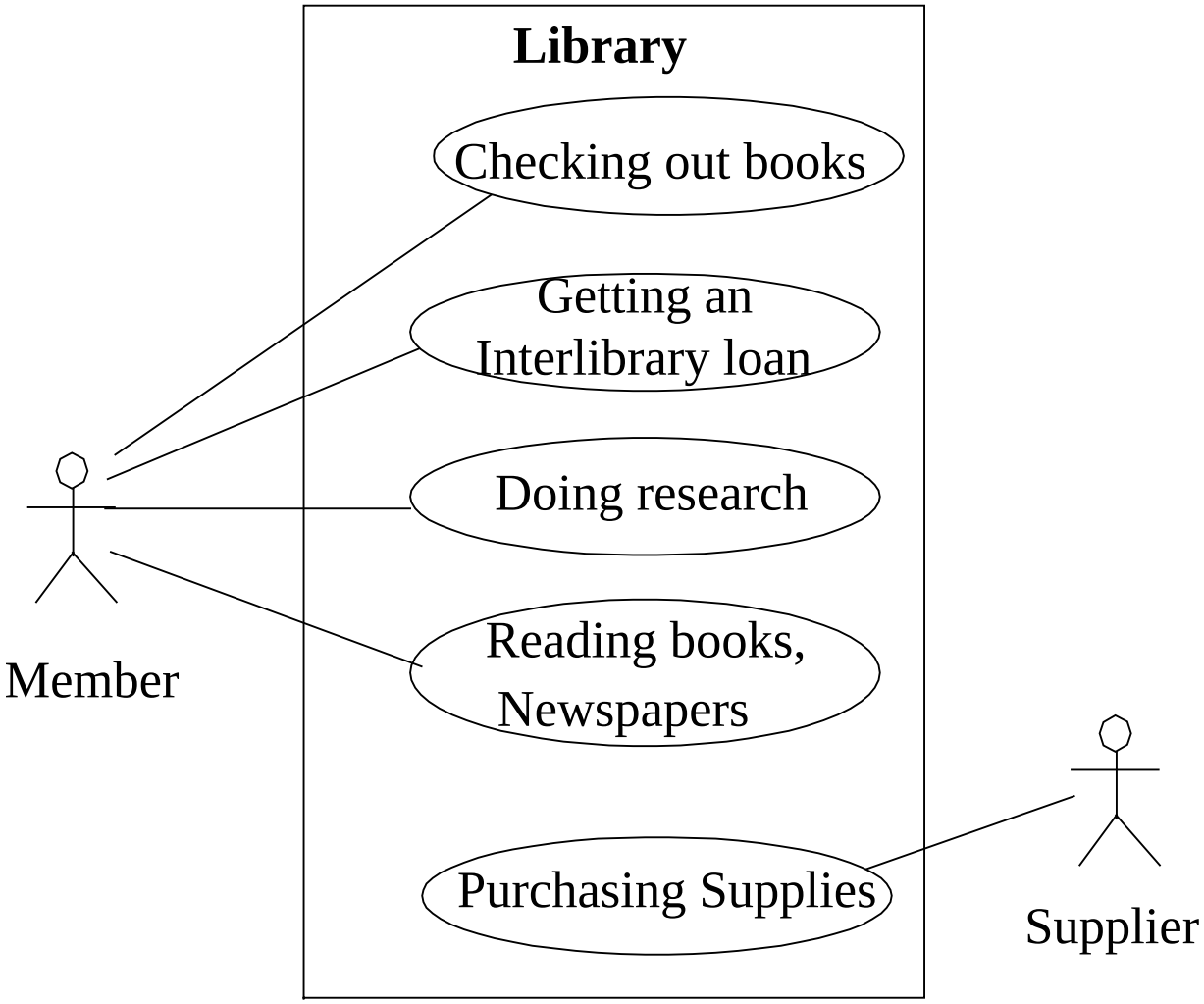
Use Cases (Con't)

- **The use case description must contain:**
  - ***How*** **and** ***when*** **the use case begins and ends.**
  - **The interaction between the use case and its actors, including** ***when*** **the interaction occurs and** ***what*** **is exchanged.**

Use Cases (Con't)

- ***How*** **and** ***when*** **the use case will store data in the system.**
- ***Exceptions*** **to the flow of events.**




Library
Checking out books
Getting an Interlibrary loan
Doing research
Reading books, Newspapers
Purchasing Supplies
Member
Supplier

Object-Oriented Software Engineering: Objectory

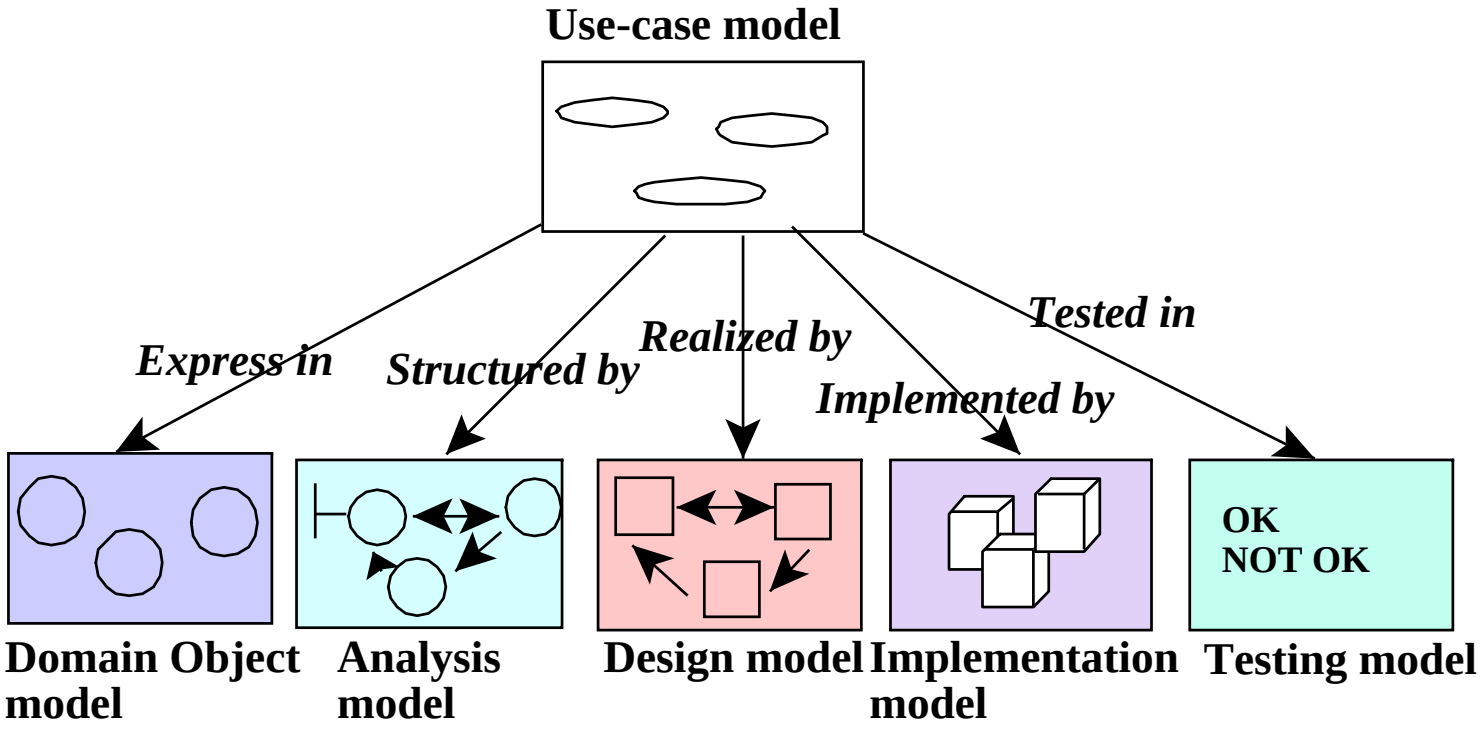
- **Object-oriented software engineering (OOSE), also called *Objectory*, is a method of object-oriented development with the specific aim to fit the development of large, real-time systems.**

Objectory (Con't)

- **Objectory is built around several different models:**
  - *Use case model.*
  - *Domain object model.*
  - *Analysis object model.*
    Implementation model.
  - *Test model.*

Object-Oriented Business Engineering (OOBE)

- **Object-oriented business engineering (OOBE) is object modeling at the enterprise level.**
- **Use cases again are the central vehicle for modeling, providing traceability throughout the software engineering processes.**


Use-case model
Express in
Structured by
Realized by
Implemented by
Tested in
OK
NOT OK
Domain Object model
Analysis model
Design model
Implementation model
Testing model

OOBE (Con't)

- **OOBE consists of :**
  - *Analysis phase*
  - *Design*
  - *Implementation phases and*
  - *Testing phase.*

Patterns

- **A pattern is an instructive information that captures the essential structure and insight of a successful family of proven solutions to a recurring problem that arises within a certain context and system of forces.**

Patterns (Con't)

- **The main idea behind using patterns is to provide documentation to help categorize and communicate about solutions to recurring problems.**
- **The pattern has a name to facilitate discussion and the information it represents.**

Patterns (Con't)

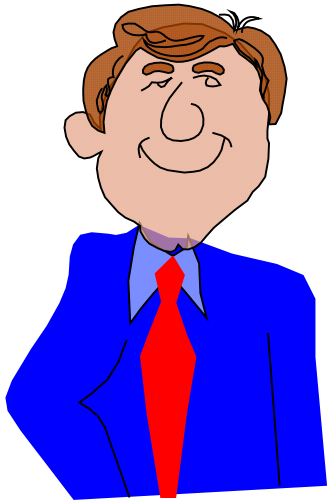
- **A good pattern will do the following:**
- ***It solves a problem*. Patterns capture solutions, not just abstract principles or strategies.**
- ***It is a proven concept*. Patterns capture solutions with a track record, not theories or speculation.**

Patterns (Con't)

- ***The solution is not obvious*. The best patterns generate a solution to a problem indirectly—a necessary approach for the most difficult problems of design.**
- ***It describes a relationship*. Patterns do not just describe modules, but describe deeper system structures and mechanisms.**

Patterns (Con't)

- **The *pattern has a significant human component*.**
- **All software serves human comfort or quality of life; the best patterns explicitly appeal to aesthetics and utility.**



Capturing Patterns

- **Guidelines for capturing patterns:**
  - *Focus on practicability.*
  - *Aggressive disregard of originality.*
  - *Nonanonymous review.*
  - *Writers' workshops instead of presentations.*
  - *Careful editing*.

Frameworks

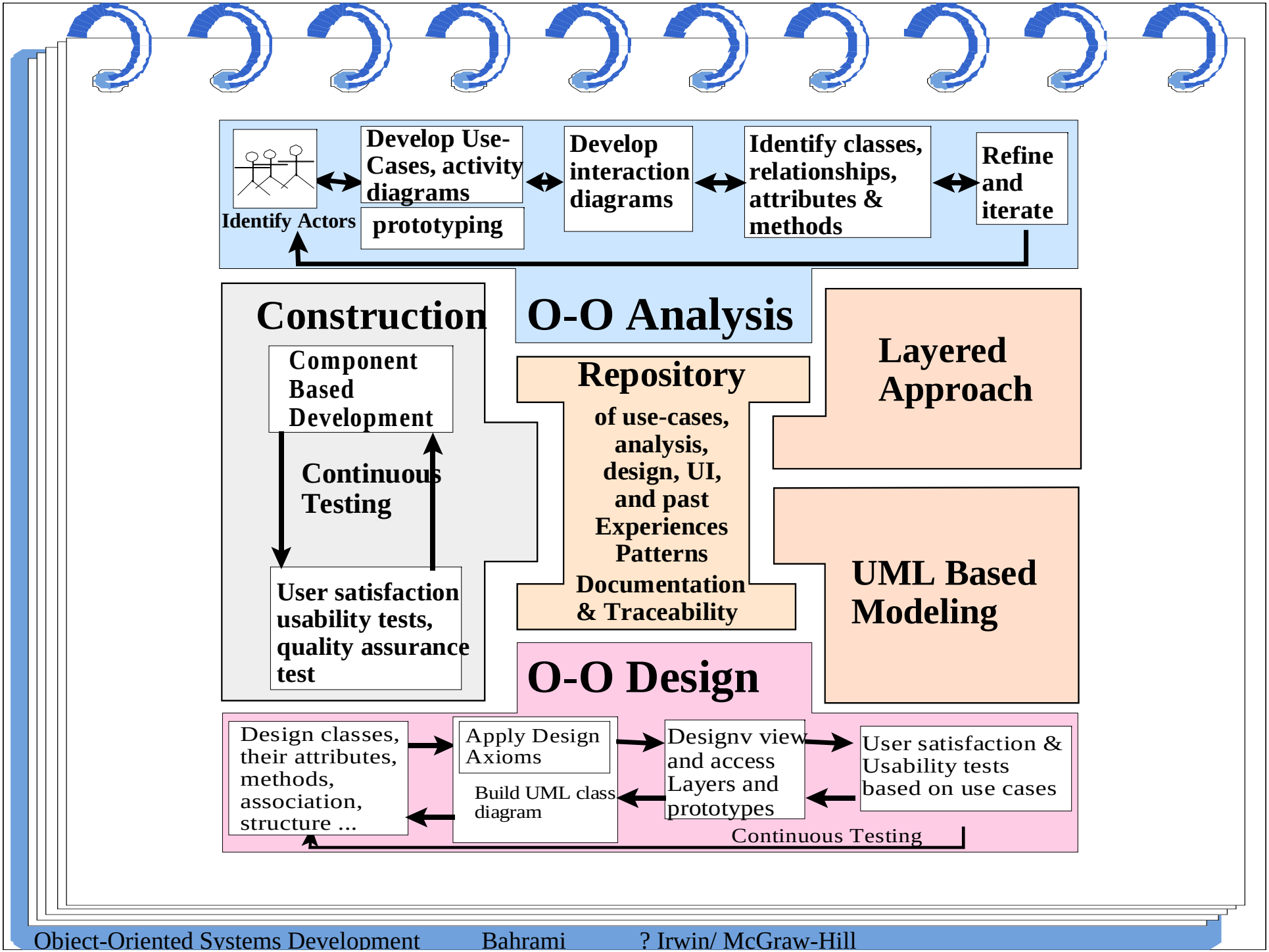
- **A *framework* is a way of presenting a generic solution to a problem that can be applied to all levels in a development.**
- **A single framework typically encompasses several design patterns and can be viewed as the implementation of a system of design patterns.**

Differences Between Design Patterns and Frameworks

- *Design patterns are more abstract than frameworks.*
- *Design patterns are smaller architectural elements than frameworks.*
- *Design patterns are less specialized than frameworks.*

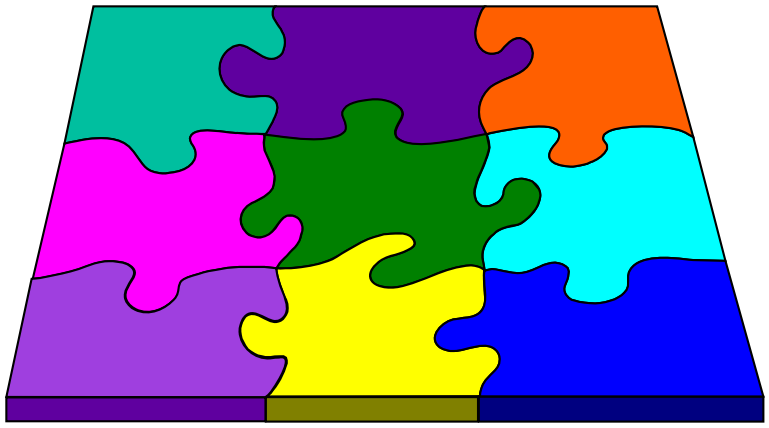
The Unified Approach

- **The idea behind the UA is not to introduce yet another methodology.**
- **The main motivation here is to combine the best practices, processes, methodologies, and *guidelines* along with UML notations and diagrams.**


Identify Actors
Develop Use-Cases, activity diagrams
prototyping
Develop interaction diagrams
Identify classes, relationships, attributes & methods
Refine and iterate
Construction
O-O Analysis
Component Based Development
Continuous Testing
User satisfaction usability tests, quality assurance test
Repository
of use-cases, analysis, design, UI, and past Experiences
Patterns
Documentation & Traceability
Layered Approach
UML Based Modeling
O-O Design
Design classes, their attributes, methods, association, structure ...
Apply Design Axioms
Build UML class diagram
Designv view and access Layers and prototypes
User satisfaction & Usability tests based on use cases
Continuous Testing

The Unified Approach (UA)

- **The unified approach to software development revolves around (but is not limited to) the following processes and components.**



UA Processes (Con't)

- **The processes are:**
  - **Use-case driven development.**
  - **Object-oriented analysis.**
  - **Object-oriented design.**
  - **Incremental development and prototyping.**
  - **Continuous testing.**

UA Methods and Technology

- **The methods and technology employed includes:**
  - **Unified modeling language (UML) used for modeling.**
  - **Layered approach.**
  - **Repository for object-oriented system development patterns and frameworks.**
  - **Promoting Component-based development.**

UA Object-Oriented Analysis: Use-Case Driven

- **The use-case model captures the user requirements.**
- **The objects found during analysis lead us to model the classes.**
- **The interaction between objects provide a map for the design phase to model the relationships and designing classes.**

UA Object-Oriented Design

- **Booch provides the most comprehensive object-oriented design method.**
- **However, Booch methods can be somewhat imposing to learn and especially tricky to figure out where to start.**
- **UA realizes this by combining Jacobson et al.'s analysis with Booch's design concept to create a comprehensive design process.**

Iterative Development and Continuous Testing

- **The UA encourages the integration of testing plans from day 1 of the project.**
- **Usage scenarios or Use Cases can become test scenarios; therefore, use cases will drive the usability testing.**

Modeling Based on the Unified Modeling Language

- **The UA uses the unified modeling language (UML) to describe and model the analysis and design phases of system development.**

The UA Proposed Repository

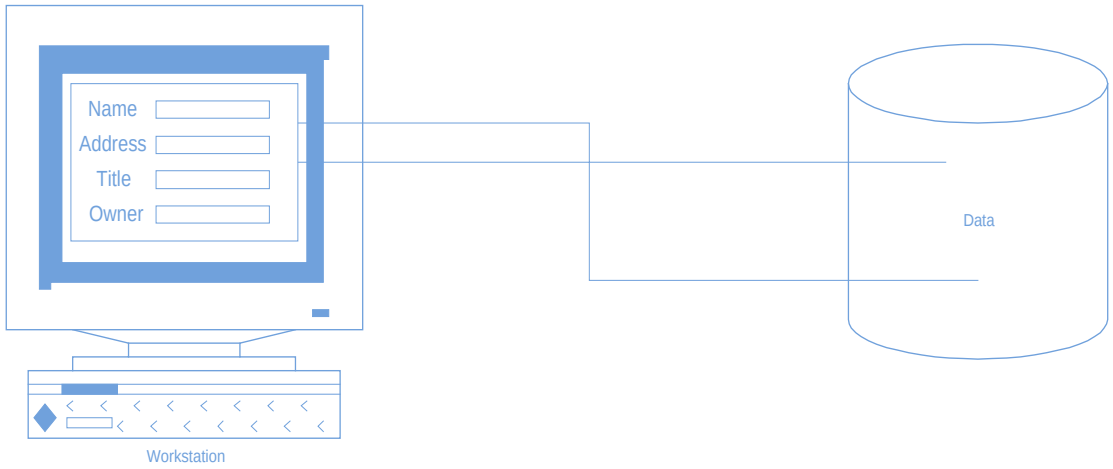
- **The requirement, analysis, design, and implementation documents should be stored in the repository, so reports can be run on them for traceability.**
- **This allows us to produce designs that are traceable across requirements, analysis, design, implementation, and testing.**

The Layered Approach to Software Development

- **Most systems developed with today's CASE tools or client-server application development environments tend to lean toward what is known as *two-layered architecture*: interface and data.**

Two-Layer Architecture

- **In a two-layer system, user interface screens are tied directly to the data through routines that sit directly behind the screens.**

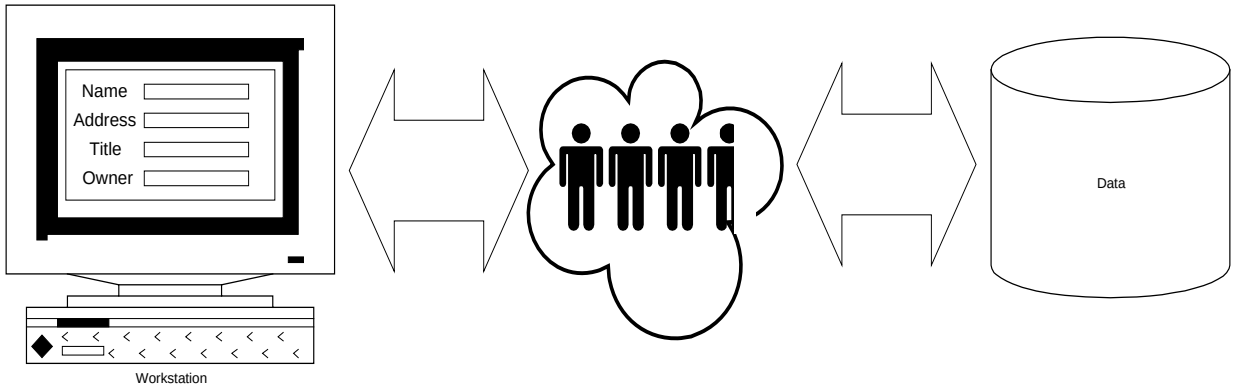


Problem With the Two-Layer Architecture

- **This approach results in objects that are very specialized and cannot be reused easily in other projects.**

Three-Layer Architecture

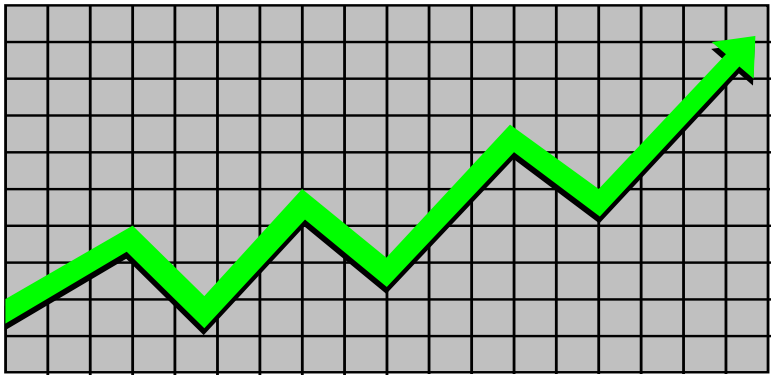
- **Your objects are completely independent of how:**
  - **they are represented to the user (through an interface) or**
  - **how they are physically stored.**



User Interface layer

This layer is typically responsible for two major aspects of the applications:

- **Responding to user interaction**
- **Displaying business objects.**



Business Layer

- **The responsibilities of the business layer are very straight-forward:**
- **model the objects of the business and how they interact to accomplish the business processes.**

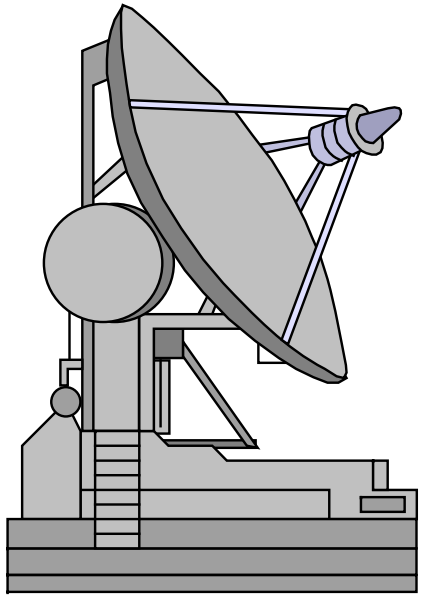
Business Layer: Real Objects (Con't)

These objects should not be responsible for:

- **Displaying details**
- **Data access details**

Access Layer

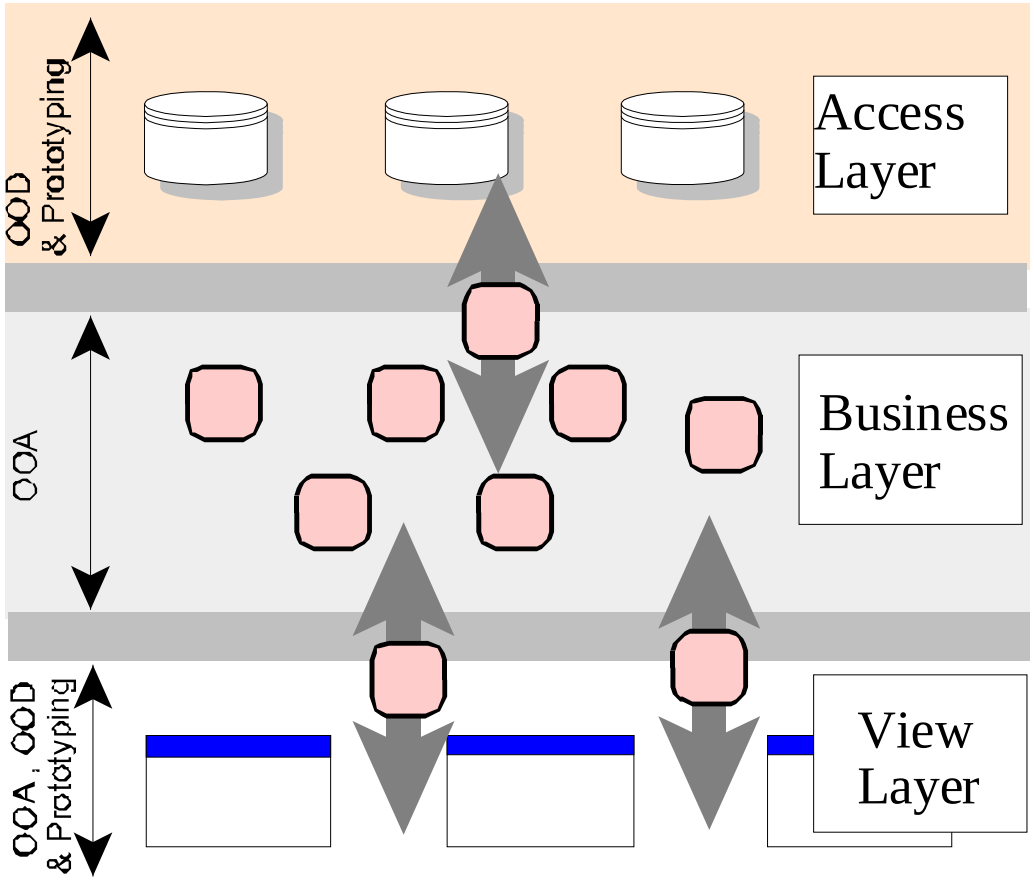
- The access layer contains objects that know how to communicate with the place where the data actually resides,
- Whether it be a relational database, mainframe, Internet, or file.



Access Layer

- **The access layer has two major responsibilities:**
- **Translate request**
- **Translate result**

Three-Layered Architecture



Summary

- **we looked at current trends in object-oriented methodologies, which have been toward combining the best aspects of today's most popular methods.**

Summary (Con't)

- **Each method has its strengths. Rumbaugh et al. have a strong method for producing object models.**
- **Jacobson et al. have a strong method for producing user-driven requirement and object-oriented analysis models.**
- **Booch has a strong method for producing detailed object-oriented design models.**

Summary (Con't)

- **Each method has weakness, too. While OMT has strong methods for modeling the problem domain, OMT models cannot fully express the requirements.**
- **Jacobson, although covering a fairly wide range of the life cycle, does not treat object-oriented design to the same level as Booch, who focuses almost entirely on design, not analysis.**

Summary (Con't)

- **The UA is an attempt to combine the best practices, processes, and guidelines along with UML notations and diagrams for better understanding of object-oriented concepts and object-oriented system development.**