Chapter 4 — Design

May 13, 2009

Outline

1. Introduction
2. Architectural Design
   - System Organization
   - Distributed Systems Architecture
3. Application Architectures
   - Types of AAs
4. Object-Oriented Design
   - Object-Oriented Design Process
5. Interface Design

Introduction

- Logical organization of software

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  - UML model

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  - sketches, drawings, notes

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  - sketches, drawings, notes
- *creative process*: no real “method”
- learn from previous design experiences

In This Chapter

- Learn about software design perspectives and ideas

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- **Architecture**: abstract formulas and patterns
- **Specific Issues**: common to most software designs
  - object-oriented design
  - user-interface design

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    - framework for sub-system control and communication

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- affects *performance*, *robustness*, *availability*, *maintainability*

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Organization

- Reflects basic strategy for the structure

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- Common organization styles:
  - repository
  - client-server
  - layered

Repository Model

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    - backup, security, access control are centralized (*agreement*)

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- System as a set of services

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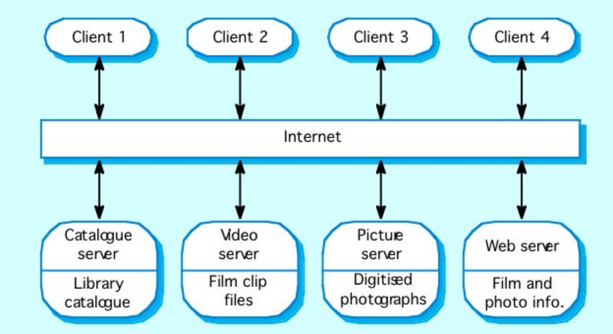
- Client *waits* for a reply

Client-Server Architecture Model

- E.g.: Video and Photo Library system's architecture



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  - XML can be used, but slow

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  - performance may suffer

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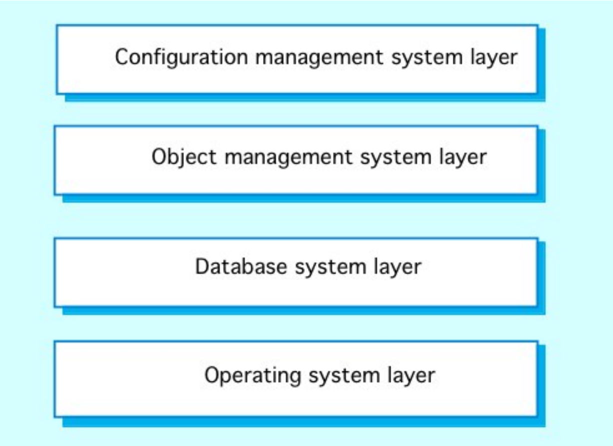

Configuration management system layer

Object management system layer

Database system layer

Operating system layer

Figure: Version Control System

Reference architectures

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  - communicate domain concepts
  - evaluate possible architectures

Example Reference Architecture

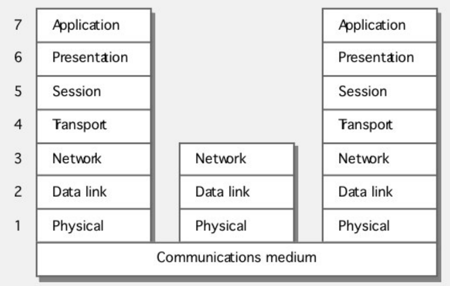

Figure: The OSI Reference Architecture for Computer Networks

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  - Unpredictability

Multi-processor Architecture

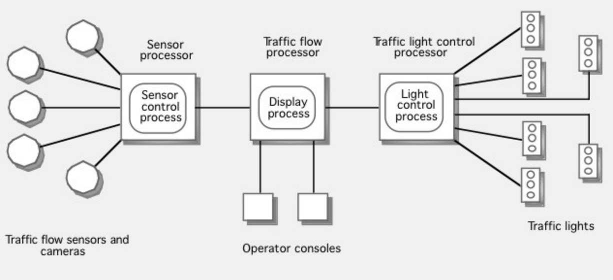


Figure: A multiprocessor traffic control system

Client-Server Architecture (CSA)

Difference between server *process* and server *computer*

CSA Example

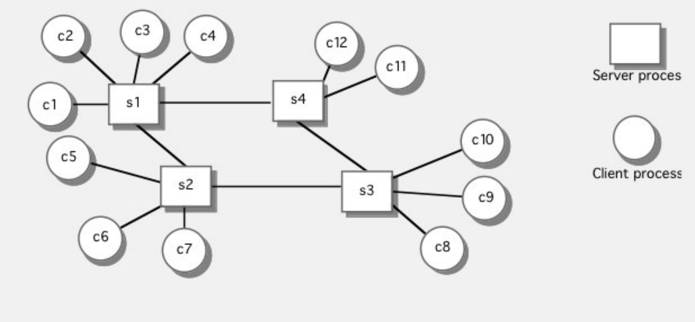


Figure: A client-server system

CSA Example

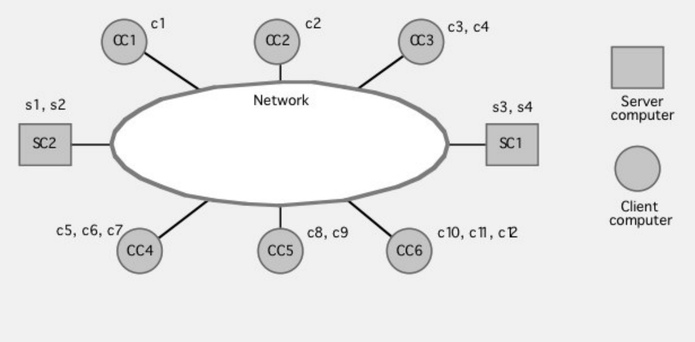
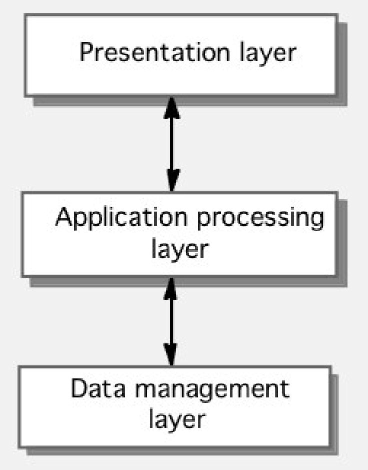


Figure: Computers in a client-server network

How to CSA-ize Your System

Distribute some/all of the MVC layers



Two-tier CSA

- Simplest CSA: a server(s) and clients

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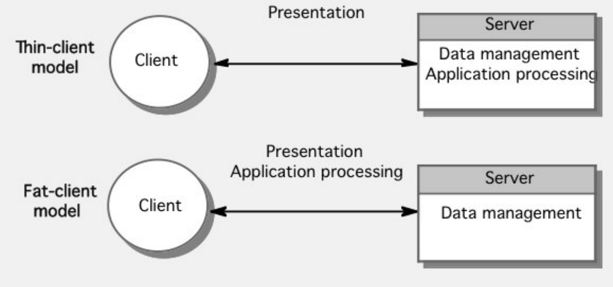
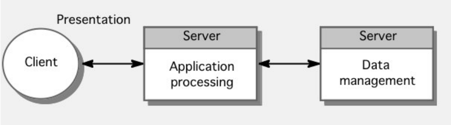
- *Thin* and *flat* client models



Three-tier CSA

- Each MVC layer on a separate computer



Other Distributed Architectures

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  - standards (based on XML)
    - SOAP
    - WSDL
    - UDDI

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  - previous perspective: control, distribution, structure
- Issues to common to applications of a certain kind

Use of AA

- As s/w developer, AAs are useful as
  - starting point for design process

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  - assessing components for reuse

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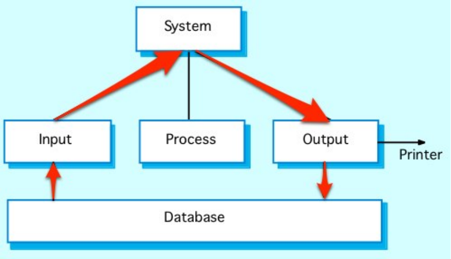

Figure: Model of data-processing applications

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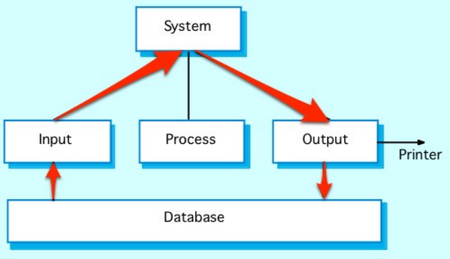

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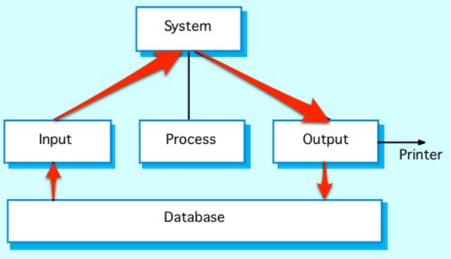

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    - ∴, function-oriented rather than OO

Data-Flow Diagrams

- DFDs are useful to describe data-processing applications

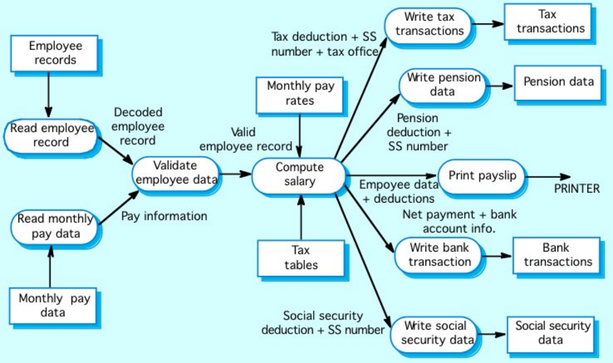

Figure: DFD for a payroll system

Transaction-Processing Systems

- Process user requests for DB read / update

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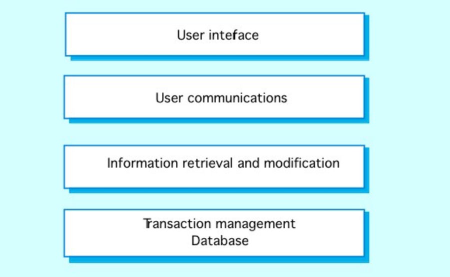

Figure: Layered architecture of a transaction processing system

Event Processing Systems

- Respond to user or system events

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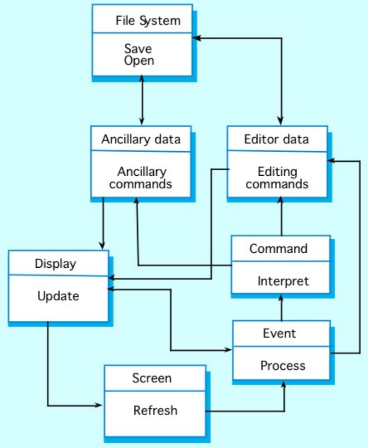

Figure: Architecture of Event-driven system

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- classes are related to problem
- state representation is private
- system is easy to modify → objects (classes) since they are independent
- objects are reusable

Objects and classes

- **Object**: entity{state, operations}

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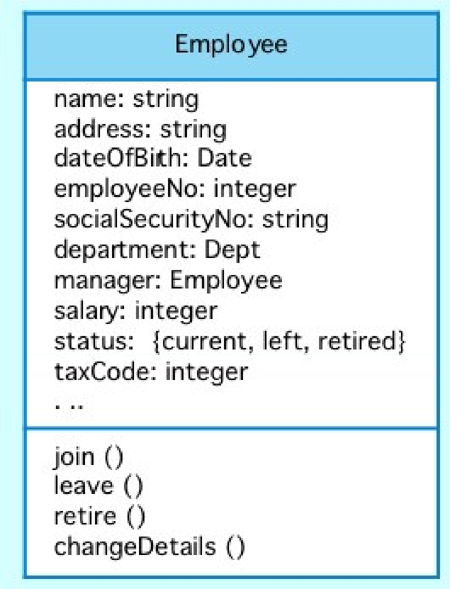
- Objects created from a *class*: definition of template

An Employee object class (UML)

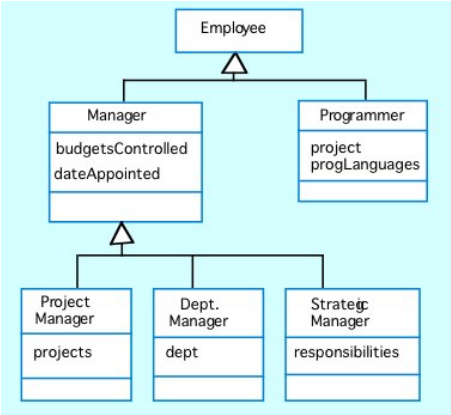


Employee

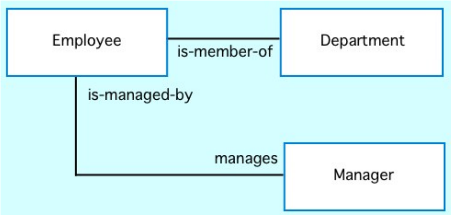
name: string
address: string
dateOfBirth: Date
employeeNo: integer
socialSecurityNo: string
department: Dept
manager: Employee
salary: integer
status: {current, left, retired}
taxCode: integer
. ..

join ()
leave ()
retire ()
changeDetails ()

Example Class Hierarchy (Generalization)



Association Model



Concurrent Objects

- Objects execute concurrently

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- However, service requests are *procedural*

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- Threads allow for full concurrency even with service requests

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- Usually an iterative, interleaved process

Example: a weather mapping system

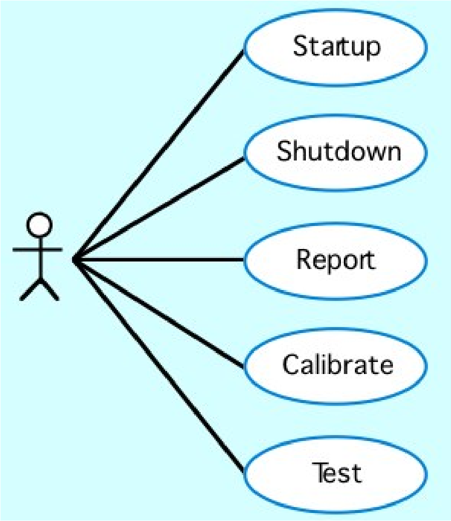
Basics

- System description
  - generates weather maps from data collected from several sources
  - collect and integrate data into an archive
  - use archive and digitized map to display/print weather map

Use Case and Context

- Context: how the system is connected in its environment
- Use case: ways in which system can be used

Use-cases for weather station



Compltete System Architecture

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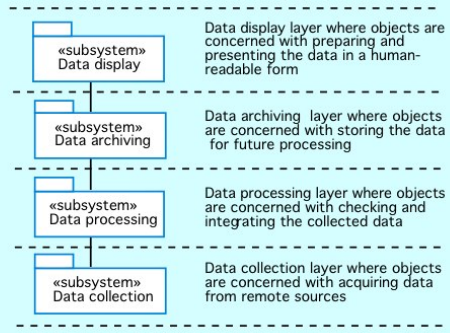


«subsystem» Data display

Data display layer where objects are concerned with preparing and presenting the data in a human-readable form

«subsystem» Data archiving

Data archiving layer where objects are concerned with storing the data for future processing

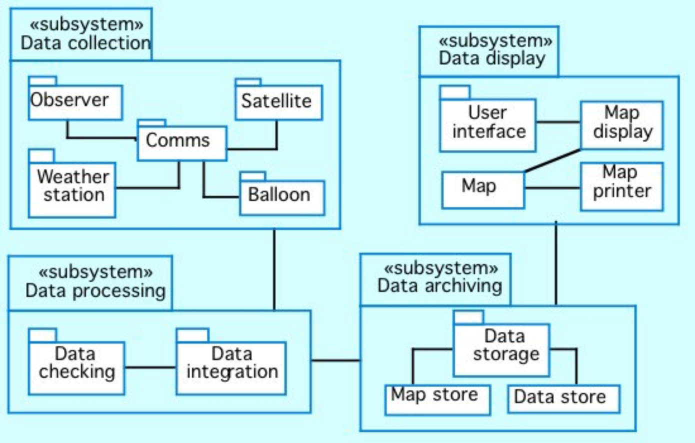
«subsystem» Data processing

Data processing layer where objects are concerned with checking and integrating the collected data

«subsystem» Data collection

Data collection layer where objects are concerned with acquiring data from remote sources

Subsystems in the Architecture



System Architecture of Weather Station

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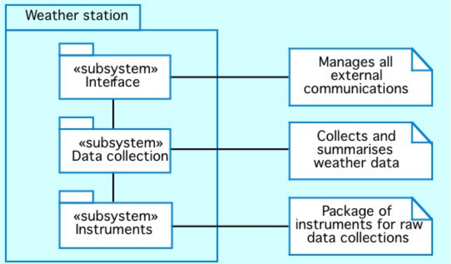
Weather station
«subsystem» Interface
«subsystem» Data collection
«subsystem» Instruments
Manages all external communications
Collects and summarises weather data
Package of instruments for raw data collections

Object Identification

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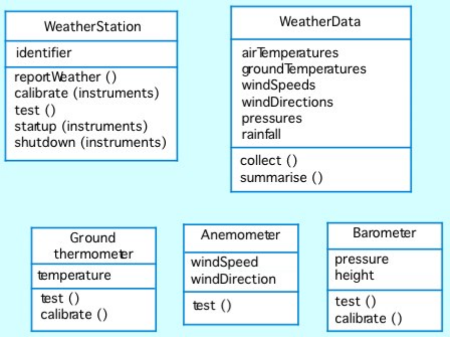

WeatherStation
identifier
reportWeather ()
calibrate (instruments)
test ()
startup (instruments)
shutdown (instruments)

WeatherData
airTemperatures
groundTemperatures
windSpeeds
windDirections
pressures
rainfall
collect ()
summarise ()

Ground thermometer
temperature
test ()
calibrate ()

Anemometer
windSpeed
windDirection
test ()

Barometer
pressure
height
test ()
calibrate ()

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- or *choose certain level of detail in single model*

Static and Dynamic models

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  - describe system structure with classes and relationships

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- Other model types in UML: *use case*, *object models*, *generalization*, etc.

Subsystem Models

- Objects in weather station package:

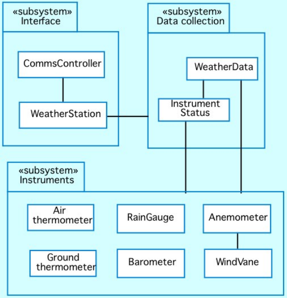

Figure: Weather station packages

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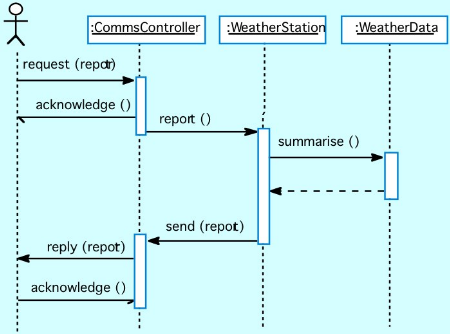

Figure: Sequence of operations in data collection

Sequence Diagrams

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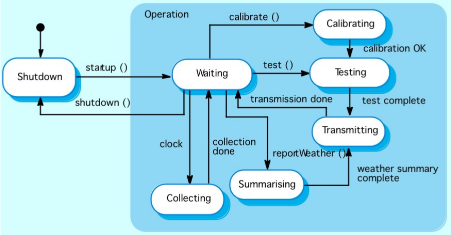

Figure: State diagram for weather station

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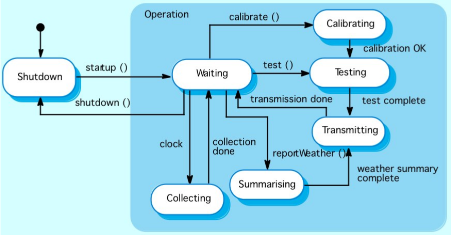

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- States can be helpful when implementing the class

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    - use `interface` and let classes implement an interface
- Simply use Java (or another OO PL) to define interfaces

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Outline

1. Introduction
2. Architectural Design
   - System Organization
   - Distributed Systems Architecture
3. Application Architectures
   - Types of AAs
4. Object-Oriented Design
   - Object-Oriented Design Process
5. Interface Design

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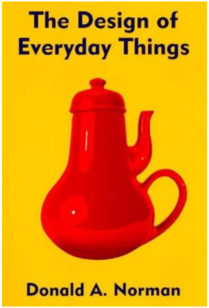

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Issues of Interface Design

Answer two questions:

- How should user interact with system?
- How should information be presented to user?

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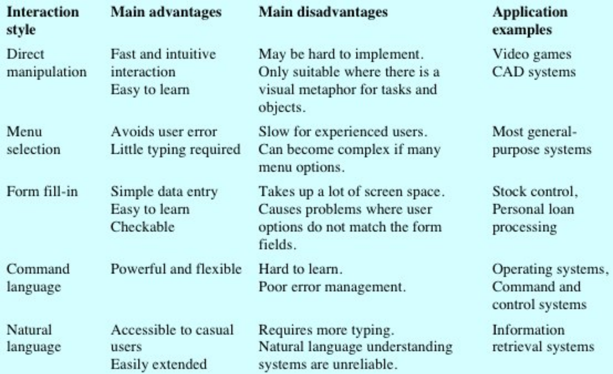
Comaprisons of Interface Styles



Interaction style	Main advantages	Main disadvantages	Application examples
Direct manipulation	Fast and intuitive interaction Easy to learn	May be hard to implement. Only suitable where there is a visual metaphor for tasks and objects.	Video games CAD systems
Menu selection	Avoids user error Little typing required	Slow for experienced users. Can become complex if many menu options.	Most general-purpose systems
Form fill-in	Simple data entry Easy to learn Checkable	Takes up a lot of screen space. Causes problems where user options do not match the form fields.	Stock control, Personal loan processing
Command language	Powerful and flexible	Hard to learn. Poor error management.	Operating systems, Command and control systems
Natural language	Accessible to casual users Easily extended	Requires more typing. Natural language understanding systems are unreliable.	Information retrieval systems

Figure: Interaction Styles Merits/Demerits

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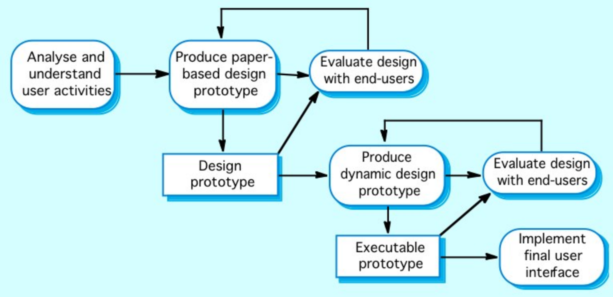
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Evaluate design with end-users
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Evaluate design with end-users
Executable prototype
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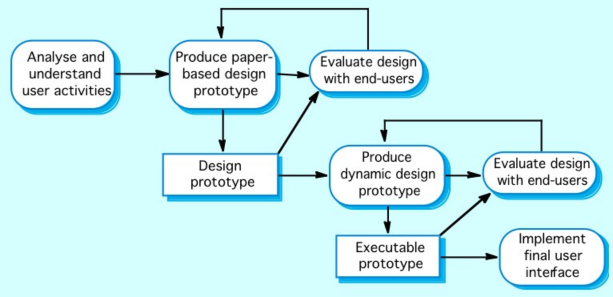
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