Systems Analysis & Design
DESIGN WOOO

CIS641
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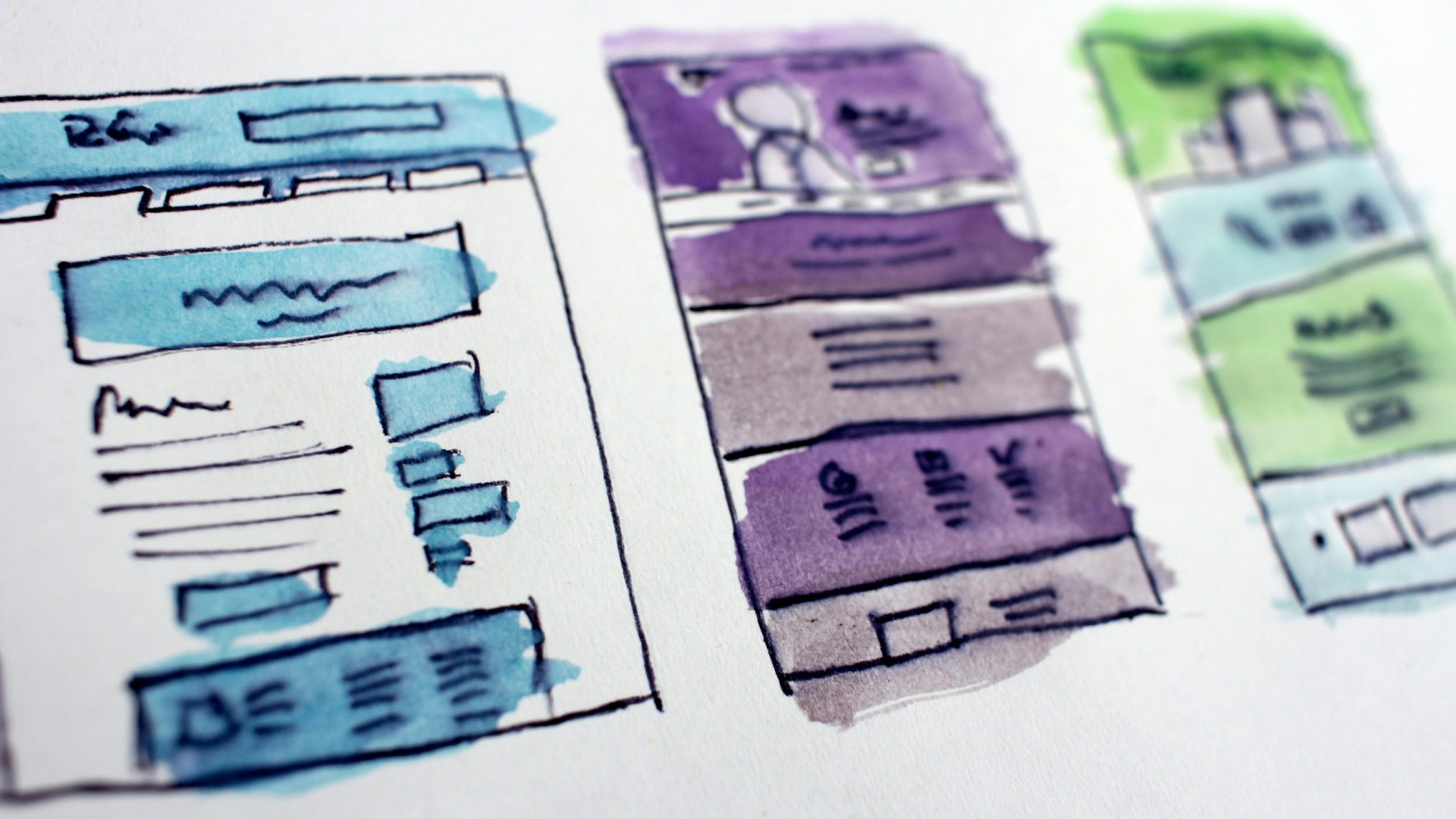
Adapted from materials provided by Gregory Schymik and the textbook (Systems Analysis and Design 5th Ed.)



What are we doing today?

Understand the verification and validation of the analysis models

Understand the transition from analysis to design

Understand the use of factoring, partitions, and layers

Be able to create package diagrams

Be familiar with the custom, packaged, and outsource design alternatives

Be able to create an alternative matrix

Introduction

Analysis determines the business needs

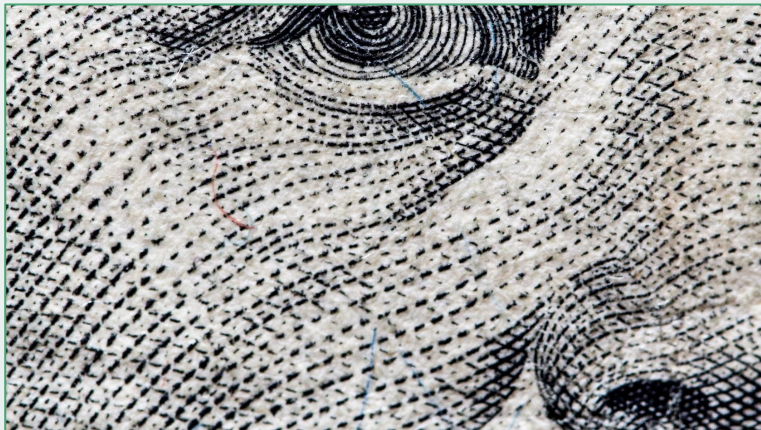
Design activities focus on how to build the system

- Major activity is to evolve the models into a design
- Goal is to create a blueprint for the design that makes sense to implement
- Determine how and where data will be stored
- Determine how the user will interface with the system (user interface, inputs and outputs)
- Decide on the physical architecture

Analysis and design phases are highly interrelated and may require much “going back and forth”

- Example: prototyping may uncover additional information

Do we build it or buy it?



What are some "classic" issues?

(Sidebar in Ch 7)

- Reduce design time
- Feature creep
- Silver bullet syndrome
- Switching tools midproject

How do you deal with each of these?

Difference between analysis and design models

Analysis model ➜ generally ignores non-functional requirements

Design model ➜ takes them into account, plus functionals

What are non-functionals again?

- The "ilities"

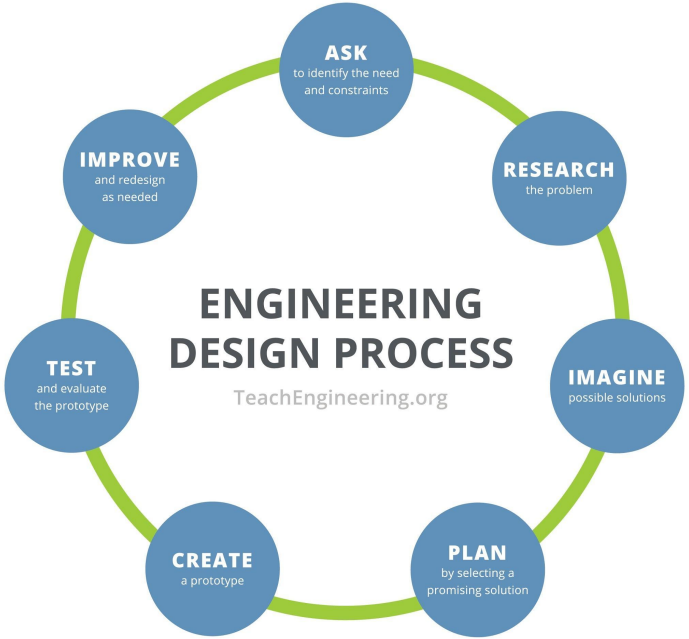
The Design Process

Verify and validate the analysis models

Evolve the analysis models into design models

Create packages and utilize package diagrams

Decide upon a design strategy



V&V the analysis models

Do the analysis models accurately represent the problem domain?

- Test the fidelity of each model
- Example: activity diagrams, use-case descriptions and use-case diagrams should all describe the same functional requirements

Balance the models to ensure consistency between them

And now for some rules/practices!

Balancing structural/functional models

A class on a class diagram must be associated with at least one use-case

An activity in an activity diagram and an event in a use-case description should be related to one or more operations on a class diagram

An object node on an activity diagram must be associated with an instance or an attribute on a class diagram

An attribute or an association/aggregation relationship on a class diagram should be related to the subject or object of a use-case

Balancing structural/functional models

Sequence and communication diagrams must be associated with a use-case

Actors on sequence & communication diagrams or CRUDE matrices must be associated with actors within a use-case

Messages on sequence & communication diagrams, transitions on behavioral state machines and entries in a CRUDE matrix must relate to activities on an activity diagram and events in a use-case

All complex objects in activity diagrams must be represented in a behavioral state machine

Balancing structural/functional models

Objects in a CRUDE matrix must be associated with classes

Behavioral state machine must be associated with objects on a class diagram

Objects in sequence and communication diagrams must be associated with objects on a class diagram

Messages on sequence and communication diagrams and transitions on behavioral state machines must be associated with operations in a class

States in a behavioral state machine must match the different values of an attribute of an object

But what does this mean?

Ensuring **consistency** among **all** of your analysis models

- Do functional / structural models agree?
- Functional / behavioral?
- Are they **trustworthy?**

An activity!

Let's balance this class diagram, sequence diagram, and use-case diagram

The PDFs are in this week's folder in Blackboard
Use the prior slides to help you balance

In-class assignment:

1) Find **as many inconsistencies as you between the models using the rules of V&V**
2) Nominate one person to share their findings (and one to submit the in-class assignment -- with your names on it)

You have 10 minutes!

- Your time starts.....now!
- (Watch Taskmaster if you don't get this reference)
    - All the episodes are free on YouTube and they are glorious British comedy

And now for some transitioning!

Evolving analysis into design models

Analysis models focused on functional requirements

Design models must include non-functional requirements as well

- System performance
- System environment issues
  - Distributed vs. centralized processing
  - User interface
  - Database

The system must be maintainable and affordable, efficient and effective

Utilize factoring, partitions & collaborations, and layers

Also known as...

Thinking about actually ... writing code!

Class diagrams transition from a *what* to a ***how***

Why?

Increase likelihood of successful system delivery

- Refine models by adding **environment / problem domain**

Are all classes necessary? Any missing?

- Attributes / methods?

Factoring

Creating modules that account for similarities and differences between units of interest

New classes formed through a:

- Generalization (a-kind-of) relationship, or a
- Aggregation (has-parts) relationship

Abstraction—create a higher level class (e.g., create an Employee class from a set of job positions)

Refinement—create a detailed class (e.g., create a secretary or bookkeeper from the Employee class)

Factoring

Organizing modules

- Consider generalizing and grouping modules
- Common functions: **Abstraction**
  Refinement

E.g., abstracting features into a superclass / subclass

Employee ➜ Nurse / Receptionist / Doctor / ...

- Generalize!

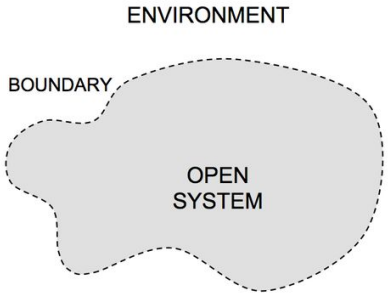
Partitions and collaborations

Partition: create a **sub-system** of closely collaborating classes

- Base partitions on patterns of activity (e.g., collaborations found in a communication diagram)
- Greater coupling among classes may identify partitions (e.g., more messages passed between objects suggests that they belong in the same partition)

Identifying partitions and collaborations determines which classes should be grouped together

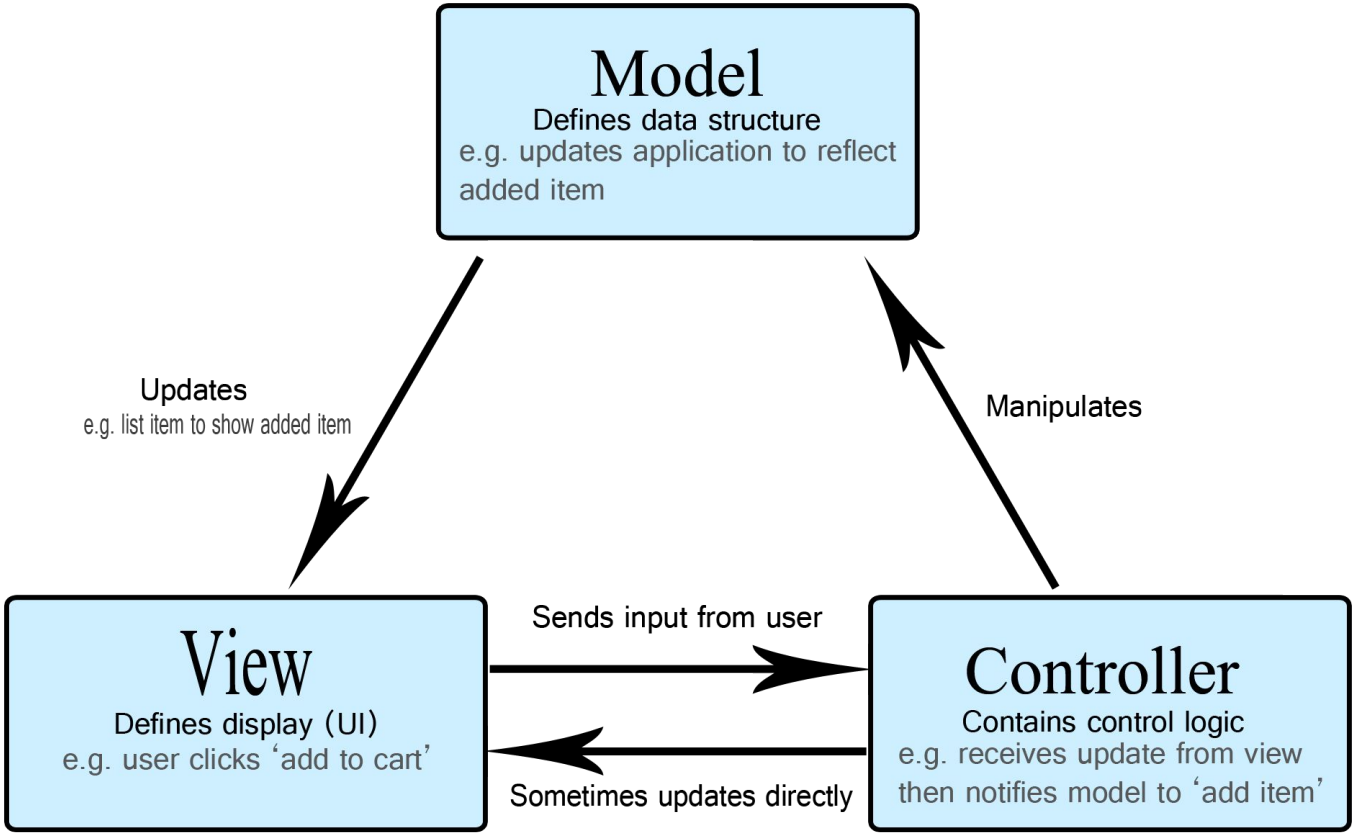
Layers



System environment information must now be added

Use layers to represent and separate elements of the software architecture

- Easier to understand a complex system
- Example:
  - Model-view-controller (MVC) architecture
  - Separates application logic from user interface
  - Proposed layers:
    - Foundation (e.g., container classes)
    - Problem domain (e.g., encapsulation, inheritance, polymorphism)
    - Data management (e.g., data storage and retrieval)
    - User interface (e.g., data input forms)
    - Physical architecture (e.g., specific computers and networks)


Model
Defines data structure
e.g. updates application to reflect added item
Updates
e.g. list item to show added item
Manipulates
View
Defines display (UI)
e.g. user clicks 'add to cart'
Sends input from user
Sometimes updates directly
Controller
Contains control logic
e.g. receives update from view then notifies model to 'add item'

Packages / Package diagrams

Packages group together similar components (e.g., use-cases, class diagrams)

Package diagrams show the packages and their relationships

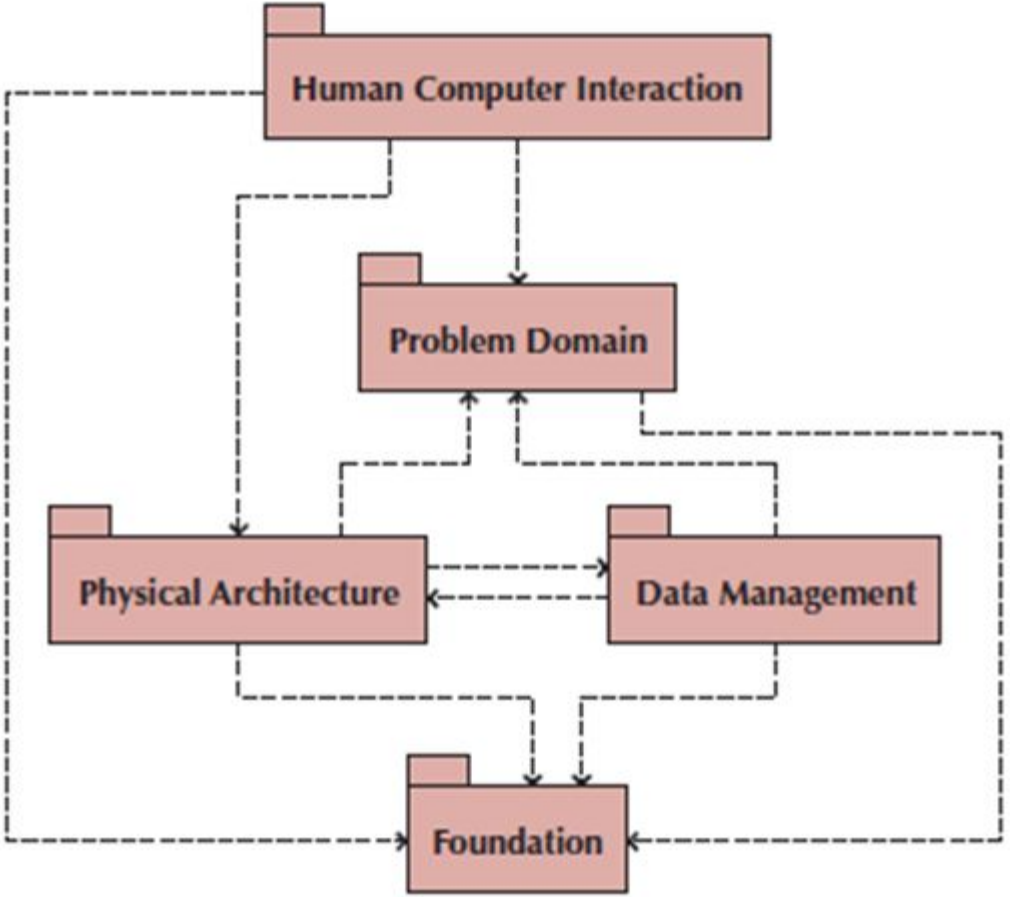
- Aggregation and association relationships are possible
- Packages may be dependent upon one another
    - If one package is modified, others that depend on it may also require modification

Package

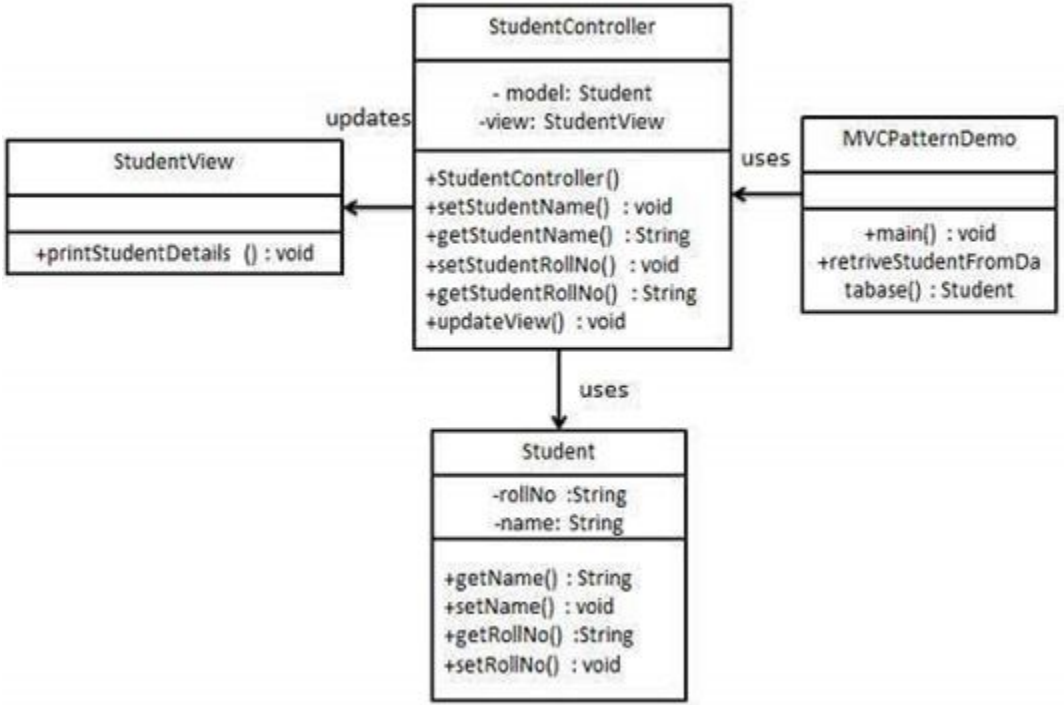
A general construct that groups units together
Used to reduce complexity of models
A package diagram shows packages only

A package: ■ Is a logical grouping of UML elements ■ Is used to simplify UML diagrams by grouping related elements into a single higher-level element.	
A dependency relationship: ■ Represents a dependency between packages: If a package is changed, the dependent package also could have to be modified. ■ Has an arrow drawn from the dependent package toward the package on which it is dependent.	

Sample package diagram



Model-View-Controller (MVC) example



Why layers?

Evolve analysis model into design model!

- Add system environment information
- Use layers (avoids overloading developer)

Package diagram guidelines

Use them to logically organize your design

Observe semantic relationships

- **Vertical positioning** indicates inheritance
- **Horizontal positioning** indicates aggregation and association

Dependency relationships should also observe semantic relationships

For use-case package diagrams, include the actors

Use simple but descriptive names for each package

Make packages cohesive

Building package diagrams

Set the context

Cluster classes together based on shared relationships

Create packages from the clusters

Identify dependency relationships among packages

Lay out and draw the diagram including only the packages and their dependencies

Verify and validate the package diagram

V&V?

Focus on 2 key points:

1) Packages must make **sense** from problem domain perspective

2) Dependency relationships must be **based on message-sending relationships** from:
    a) Communications diagrams
    b) CRUDE matrix entries
    c) Class diagram associations

Design strategies

Custom development—build it in house from scratch

Purchase packaged software

- Office suites (e.g., word processors, spreadsheets, etc.)
- Enterprise systems (e.g., SAP, PeopleSoft)

Hire an external vendor (outsource)

Custom development

Allows for meeting highly specialized requirements\

Allows flexibility and creativity in solving problems

Easier to change components

Builds personnel skills

May excessively burden the IT staff

May add significant risk

What burdens/risks does custom dev. provide?

?

Packaged software

Software already written (e.g., accounting software)

May be more efficient

May be more thoroughly tested and proven

May range from components to tools to entire enterprise systems

Must accept functionality provided

May require change in how the firm does business

May require significant “customization” or “workarounds”

System integration

Building a new system by combining packages, legacy systems, and new software

- Not uncommon to purchase off the shelf software and outsource its integration to existing systems

Key challenge is integrating data

- May require data transformations

New package may need to write data in the same format as a legacy system

- Develop “object wrappers”

Wraps the legacy system with an API to allow newer systems to communicate with it

- Protects the investment in the legacy system

Outsourcing

Hire an external firm to create the system

- Requires extensive two-way coordination, information exchange and trust
- Disadvantages include loss of control, compromise confidential information, transfer of expertise
- Carefully choose your vendor
- Carefully prepare the contract and method of payment

Contract types:

- Time-and-arrangement: pay for all time and expenses
- Fixed-price: pay an agreed upon price
- Value-added: pay a percentage of benefits

Selecting a design strategy

	Use Custom Development When…	Use a Packaged System When…	Use Outsourcing When…
Business Need	The business need is unique.	The business need is common.	The business need is not core to the business.
In-house Experience	In-house functional and technical experience exists.	In-house functional experience exists.	In-house functional or technical experience does not exist.
Project Skills	There is a desire to build in-house skills.	The skills are not strategic.	The decision to outsource is a strategic decision.
Project Management	The project has a highly skilled project manager and a proven methodology.	The project has a project manager who can coordinate the vendor's efforts.	The project has a highly skilled project manager at the level of the organization that matches the scope of the outsourcing deal.
Time frame	The time frame is flexible.	The time frame is short.	The time frame is short or flexible.

Selecting an **acquisition** strategy

Determine tools and skills needed for in-house development

Identify existing packages that satisfy the users' needs

Locate companies who can build it under contract

Create an alternative matrix to organize the pros and cons of each possible choice

- Incorporate technical, economic and organizational feasibility
- Utilize an RFP or RFI to obtain cost & time estimates from potential vendors


“And now for something completely different.”
Monty Python

If time remains

Term project time!

- October 19th your presentations will occur!