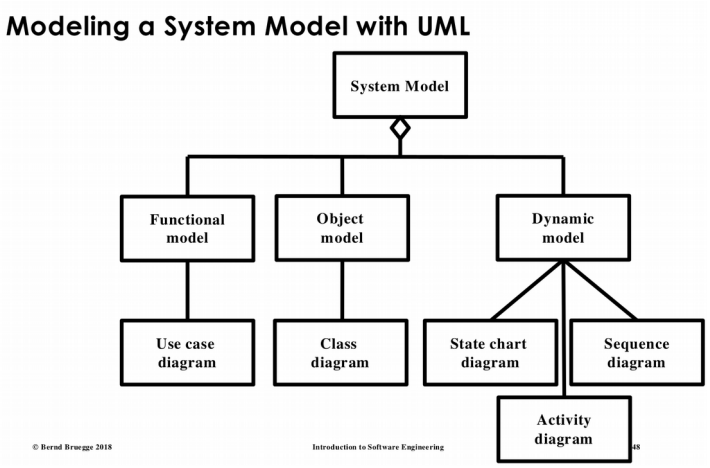
Introduction



Software Developments Models:

• Object model: What is the structure of the system?
• Functional model: What are the functions of the system?
• Dynamic model: How does the system react to external events?
• System Model: Object model + functional model + dynamic model

Software Engineering Definition:

Software Engineering is a collection of techniques, methodologies and tools that help with the production of.

Phenomenon **vs** Concept: **vs**

Phenomenon: -an object in the world of a domain as you perceive it	Concept: -describes the common properties of phenomena -3-tuple: name,purpose and members

Definitions

- Abstraction: classification of phenomena into concepts
- Modeling: development of abstraction to answer specific questions about a set of phenomena

Systems, Models and Views

- model: an abstraction describing a system
- view: despicts selected aspects of a model

Model-Based Software Engineering

Definition

- Software life-cycle: set of activities and their relationships to each other (activities: Analysis, System Design)
- Software life-cycle model: abstraction representing the development if software
- defined process: given-set of inputs, same outputs are generated every time, all activities and tasks are defined

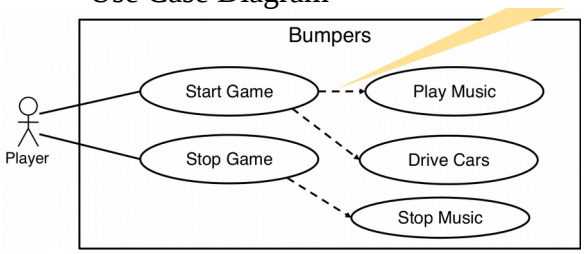
UML:

- reduces complexity by focusing on abstraction
- use:
  - Communication
  - Analysis and Design
  - Archival

Application **vs** Solution Domain

Application(Analysis): -the environment in which the system is operating	Solution Domain(Design, Implementation): -the technologies used to build the system

Use Case Diagram



Use Case

- [1]Textual Use Case: {[1.Name], [2.Participating actors], [3. Entry conditions], [4. Exit Conditions], [5. Flow of events], [6. Special requirements]}
- Use Case D.: describe the functional behavior of the system as seen by the user
  - use case represents a functionality provided by the system

<<extends>> Relationship [2]	<<includes>> Relationship[3]
-To model rarely invoked use cases or exceptional functionality. The extension use case is not meaningful by its own -The direction of the arrow in the <<extends>> association points to base use case	-To model functional behavior that is common to more than one use case. Represents functionality needed in more than one use case -Arrows in <<includes>> associations point from the base use case to the inclusion use case

Class digram

- Class D.: describe the static structure of the system

Aggregation:	Composition:
-case of an association denoting a “part of” hierarchy	-is used when the life time of component are controlled by the aggregate(parts do not exist on their own)

UML

- Entity Objects: -represents the persistent information tracked by the system
- Boundary Objects: -represents the interaction between the user and the system
- Control Objects: -represents the control tasks to be performed by the system

Actor **vs** Class **vs** Object

Actor:	Class:	Object:
-an entity outside the system. Interacting with the system	-concept from the application/solution domain -part of the system model	-specific instance of a class

Requirements Engineering

- Requirements Elicitation: -def. of the system understood by a customer or user →”Requirements specification”
- Analysis: -def. of the system understoodby a developmer → “Analysis model” [4]
- Requirements Engineering: -combination of these two. **Activity that defines the requirements**

Requirements Specification **vs** Analysis Model

Requ.Specification:	Analysis model:
-uses natural language	-uses a formal language

Requirements: describes the **users view** (identify the **what** of the system, **not how**)

1 Requirements Elicitation and Analysis
2 Ganz bestimmte relation, die nur einmal geerbt wird, zb “no charge” kann nur von “ColectMoney” extenden
3 Nicht spezifische relation, kann von mehreren erben “purchase card” muss nicht nur von “collect money” erben
4 Deutsch: Lastenheft

Types of Requirement Elicitation:

Greenfield Engineering: -dev. From scratch -requirements are **extracted** from **client** and **user**	Re-engineering: -requirements **trigged** by **new technology**	Interface Engineering: -provide services of existing systems in new environment -req. triggered by technology or new market needs

Types of Requirements

Functional Req.: -functionality: what should the software do? -external interfaces (actors)	Nonfunctional Req.: -Usability, Performance(response time, availability, accuracy), Reliability(robustness, safety), Supportability(Adaptability, Maintainability),...

Techniques to Describe Requirements

Scenario: -a **concrete**, **focused**, informal description of a single feature of the system by a **single actor(**→ written from end user's point)	Use case: -concept that describes a set of scenarios by an actor with the system	User Story: -a functional requirement from perspective of end user

Types of Scenarios

As-is scenario: -describes a current situation. It describes the usage of an existing system(used in re-engineering projects)	Visionary scenario: -describes a future system (used in all types of projects)
Evaluation scenario: -describes user tasks against which the system will be evaluated(used in demos & acceptance tests)	Training scenario: -guide a novice user through a system (used in System delivery)

Requirements Validation:

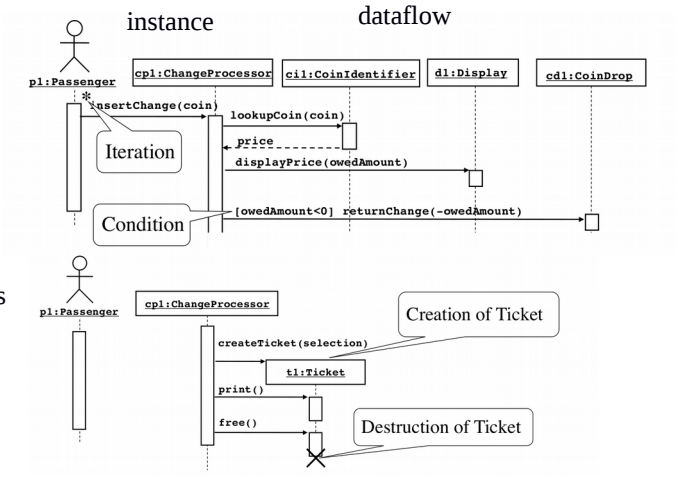
- Correctness:
- Clarity: req. can only be interpreted in one way
- completeness
- consistency: no req. that contradict each other
- realism: req. can be implemented and delivered
- Traceability: system components and behavior can be traced to the functional req.

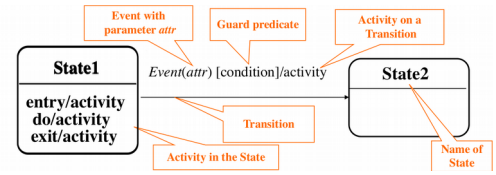
System Design

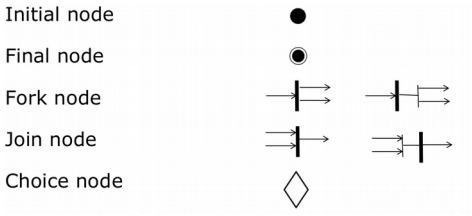
Diagrams:

Sequenz Diagrams:

- represent control flow and behavior in terms of interaction
- all messages to an object **must be public methods**
- -time consuming to build +useful to identify missing objects
- +useful to identify public methods of a class/subsystem

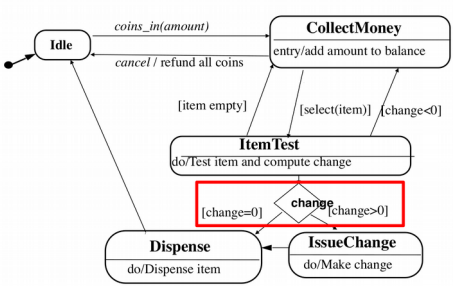






State Chart Diagrams:

- **State:** abstraction of the attributes of a class, has a duration
- event /activity, [guard predicate]

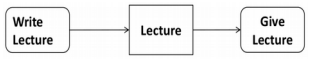


State-chart **vs** Sequence Diagram

State-chart:	Sequence:
-helps to identify changes to an individual object over time	-helps to identify temporal relationship between objects over time -sequence of operations as a response to one or more events

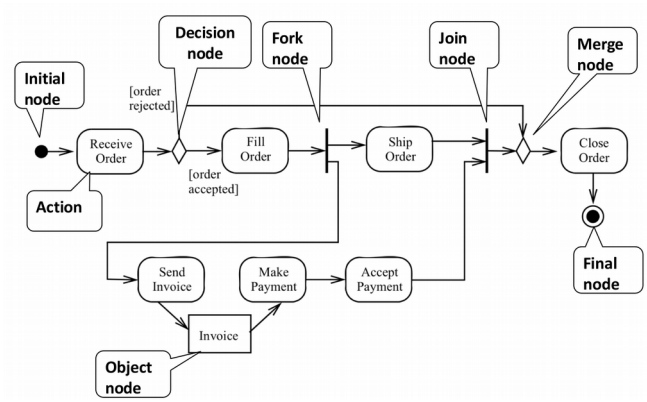
Activity Diagrams:

- **nodes** can describe activities and objects (Control nodes, Executable nodes(→ action node), object nodes
- **edge** directed connection between nodes
- decision with [ ]
- fork node for splitting and synch.

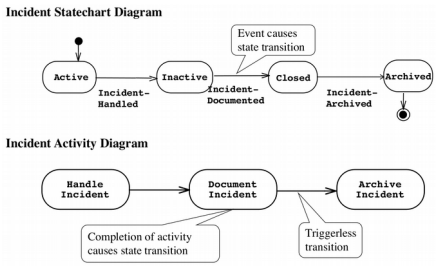


Action Node

Object Node

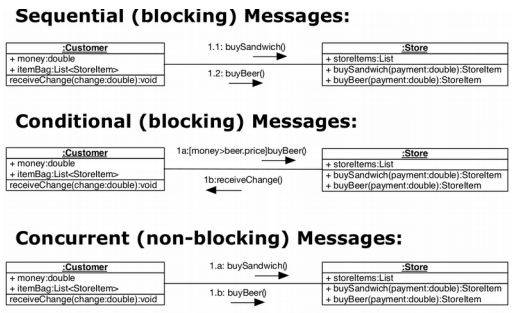


State-chart **vs** Activity Digram



Communication Diagram:

- visualizes interactions between objects as a flow of messages. Messages can be events or calls to operations
- describes the **static structure** of a system(obtained from class diagram→communication diagrams reuse layout of classes and associations)
- describes the **dynamic behavior** of a system(obtained from dynamic model(sequence & statechart diagram)
  - messages between objects are labeled with a number
- Message types:

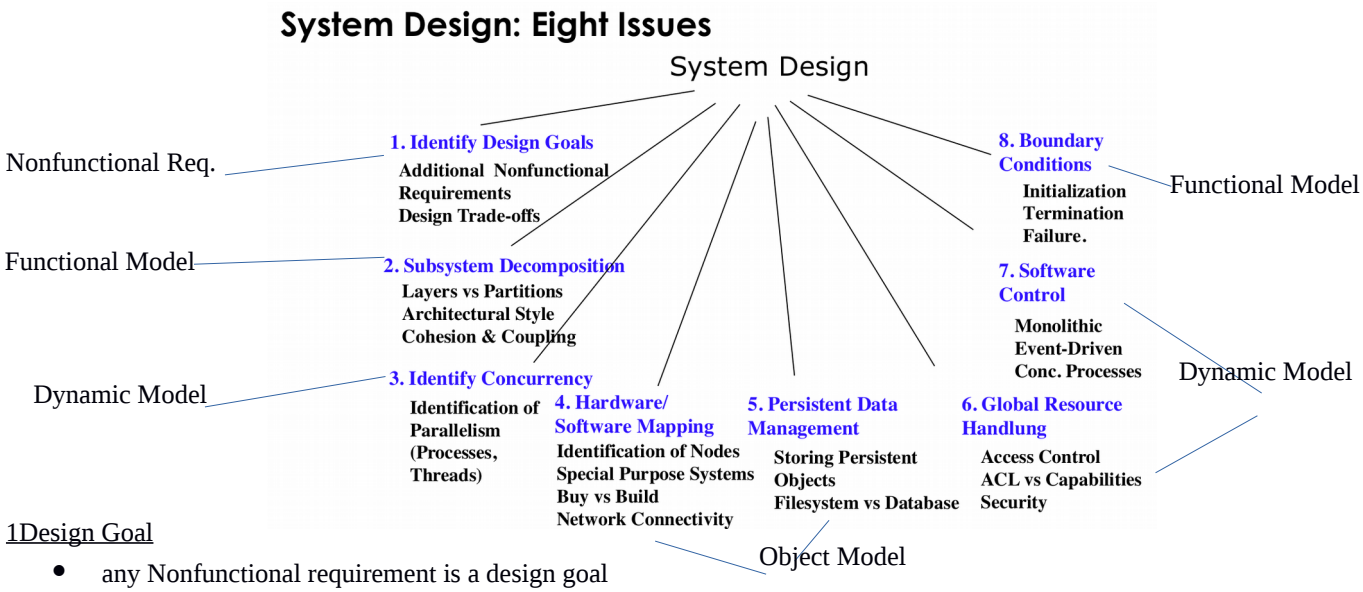


Communication **vs** Class Diagrams

- Association labels, roles and multiplicities are not shown in communication diagrams. Associations between objects denote messages depicted as a labeled arrows that indicate the direction of the message, using a notation similar to that used on sequence diagrams

Communication vs Sequence Diagrams

- Both focus on the message flow between objects Sequence diagrams are good at illustrating the event flow overtime. They can show temporal relationships such as causality and temporal concurrencies
- Communication diagrams focus on the structural view of the communication between objects, not the timing.



1Design Goal

- any Nonfunctional requirement is a design goal
- design goals often conflict with each other → design goal trade-offs

Design Goal Trade-offs

- functionality vs usability
- cost vs robustness
- efficiency vs portability
- rapid development vs functionality
- cost vs re-usability
- backward compatibility vs readability

2Subsystem Decomposition

Subsystems: collection of classes, associations, operations, events that are closely interrelated with each other

Service: group of externally visible operations provided by a subsystem(→**subsytem interface**)

Coupling vs Cohesion

Cohesion: measures dependency among classes -**high cohesion**: the classes in the subsystem perform sir tasks and are related to each other via many associations -**low cohesion**: lots of miscellaneous and auxiliary classes, almost no associations Achieve high cohesion: operations work on same attributes	Coupling: measures dependency among subsystems -**high coupling**: changes to one subsystem will have high impact on the other subsystem -**low coupling**: a change in one subsystem does not affect any other subsystem Achieve low coupling: smal interfaces,information hiding, no global data

Architectural Style vs Architecture

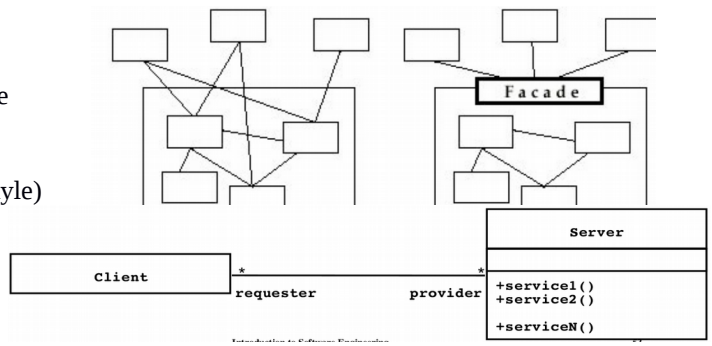
- Subsystem decomposition: -identification of subsystems, services and their relationship
- Architectural Style: -pattern fir a subsystem decomposition(e.g layered architecture: closed=can only call from layer below, open=can call from any layer below)
- Software Architecture: instance of an architectural style

System Design II

Patterns

The Facade(to reduce Coupling)

- a facade defines a higher-level interface that makes the subsystem easier to use

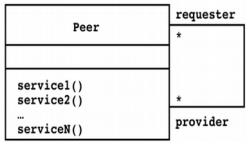


Client/Sever Architecture(special case of layerd architectural style)

- often used in database systems

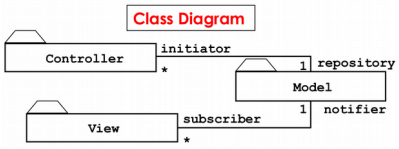
- client: input from user, front-end processing of input
- server: centralized data manegement
- problems: client/server use a req-response protocol → peer-to-peer is often needed

Peer-to-peer Architectural Style



- generalization of client/server Architecture but clients can be servers and servers can be clients

Model-View-Controller

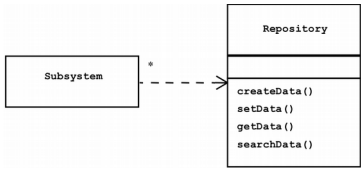


- decouples data access(entity objects) and data presentation(boundary objects)
- model: -a subsystem containing boundary objects
- view: -a subsystem containing entity objects
- controller: -a subsystem mediating between the view and the models

MVC vs. 3-Tier Architectural Style

MVC:	3-tier:
-is nonhierachical (triangular) -v sends updates to c, c updates m, v is directly updated from m	-is hierarchical(linear) -presentation layer never communicates directly with data layer -all communication must pass through middleware layer

Repository Architectural Style



- support a collection of independent programs(=Subsystems) that work cooperatively on common data structure (=Repo.)

Elements of an Architectural Style

- Components(Subsystems): units with a specified interfaces
- Connectors(Communication): interactions between the components

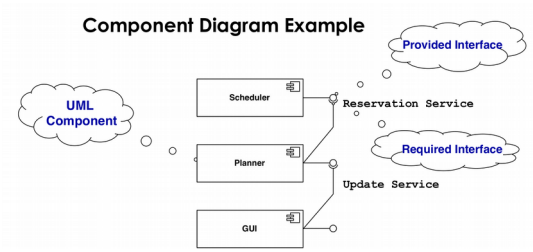
3Concurrency

- used to address nonfunctional req. such as: performance, response time… using threads

4Hardware Software Mapping

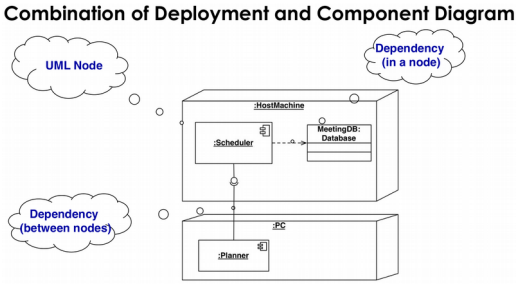
- Control Objects → Processor
- Entity Objects → Memory
- Boundary Objects → I/O Devices

Component Diagram



- shows dependencies between components at design, compilation and run-time
- UML interface describes a group of operations provided or required by a component

Deployment Diagram

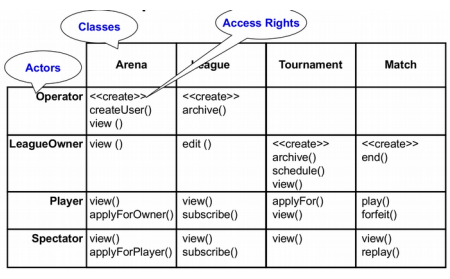


- shows the distribution of components at run-time
- uses nodes and connections to depict the physical resources in the system

5Persistent Data Management

- **persistency**: a class is persistent, if the values of their attributes have a lifetime beyond a single execution(can be done with a **file system** or a **database**

6Global Resource Handling



Actors	Arena	League	Tournament	Match
Operator	<<create>> createUser() view ()	<<create>> archive()		
LeagueOwner	view ()	edit ()	<<create>> archive() schedule() view()	<<create>> end()
Player	view() applyForOwner()	view() subscribe()	applyFor() view()	play() forfeit()
Spectator	view() applyForPlayer()	view() subscribe()	view()	view() replay()

- addresses access control→ done with an access matrix(rows=actors, column=classes)

7Software Control

- implicit software control(=role-based systems, logic programming)
- explicit software control(=centralized control,decentralized control)
- 2 sequence diagram structures to determine decentrilasation

8Boundary Conditions

- Initialization: -system is brought from a non-initial state to a steady-state
- Termination
- Failure

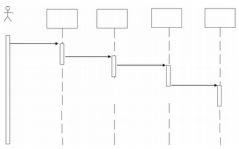


Illustration 2: Stair Diagram

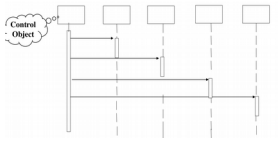


Illustration 1: Fork Diagram

Object Design

- Purpose: -prepare for the implementation, transform the system model

Consists of 4 Activities:

- Reuse: Identification of existing solutions: -use of inheritance, use of design patterns
- Interface specification: -describes precisely each class interfaces
- Object model restructuring
- Object model optimization

Reuse in Object Design

- Composition (also called black box reuse) = A new class is created by the aggregation of the existing classes. The new class offers the aggregated functionality of the existing classes
- Inheritance (also called white box reuse)= A new class is created by subclassing. The new class reuses the functionality of the superclass and may offer new functionality.

Interface Specification

- Implementation Inheritance: reuse: implemented functionality in the **super class**
- Delegation: reuse: implemented functionality in an existing object
- Specification Inheritance: reuse: specified functionality in the superclass, but functionality in the object

Implementation Inheritance vs Delegation

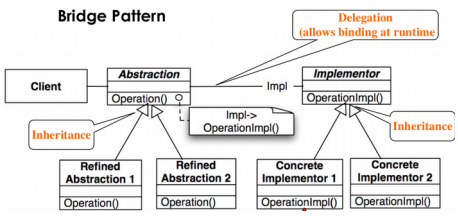
Implementation Inheritance: -extends a superclass with a subclass containing a new operation or overriding an existing operation	Delegation: -catches an operation and sens it to another object

Design Patterns

- Structural Patterns: -reduce coupling between, -introduce an abstract class for future extensions, -encapsulate complex structures
- Behavioral Pattern: -allow choice between algorithms
- Creational Patterns: -allow to abstract from complex instantiation processes

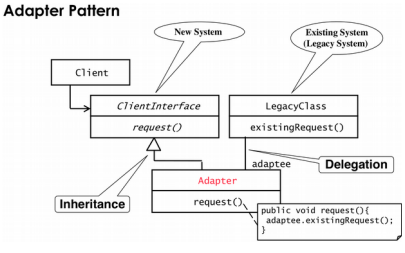
Bridge Pattern

- Problem: many design decisions are made final at design or compile time
- Bridge pattern allows to delay the binding between an interface and its subclass to the start-up time of the system

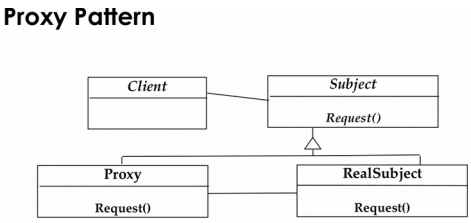


Adapter Pattern

- connects incompatible components(=wrapper)



- Proxy Pattern
- real subject is expensive to acces or to create→ proxy-object acts as a representative for the remote object and access the remote object only if really needed
- applicability: -caching(**remote proxy**), -substitute(**virtual proxy**)=object is expensive to create or to download, -access control(**protection proxy**)



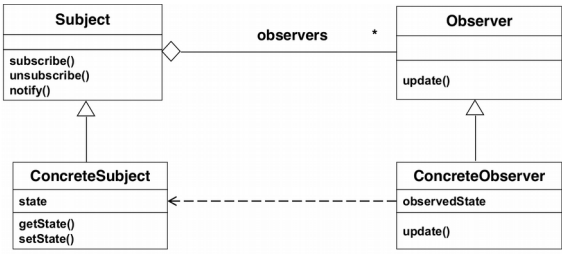
Adapter vs Bridge

-both hide the details of the underlying implementation

Adapter: -adapter pattern making unrelated components work together -applied to systems that are already designed →inheritance followed by delegation	Bridge -is used up-front in a design to let abstractions and implementations vary independently →delegation followed by inheritance

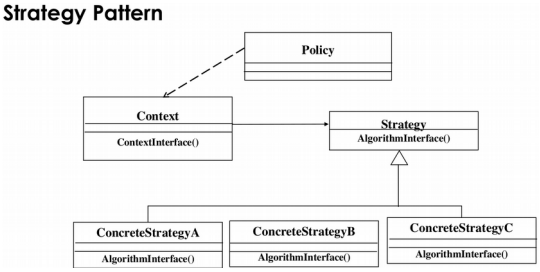
Observer Pattern (Publish and Subscribe)

- problem: object that changes its state quite often
- models a 1-to-many dependency between objects: -connects the state of an observed object(=**subject**) with many observing objects(=observers)
- usage: -maintaining consistency across redundant states



Strategy Pattern

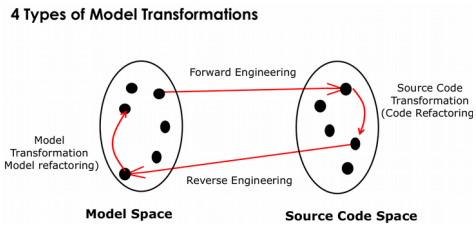
- problem: different algorithms exist for a specific task → switch between algorithms at run time
- policy decides which “ConcreteStrategy” is best in a given context



Model Transformations and Refactoring

Model Based Software Engineering

- application of modeling to support req. , design, analysis



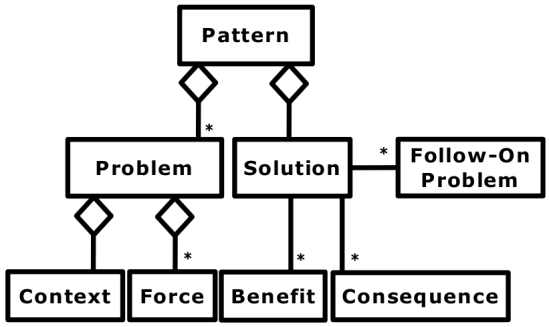
Refactoring

- a change made to the internal structure of source code to make it: -easier to understand, -without changing its observable behavior

Refactor

- to restructure source code by applying a series of refactoring

Pattern Based Development



Pattern in UML

UML

- Context: sets stage where pattern takes place
- Forces: describes why problem is difficult to solve

Examples

- Text: “must interface with an existing object” → Adapter Pattern
- Text: “must interface to several systems, some of them to be developed in the future”, “an early prototype must be demonstrated”, “must provide backward compatibility” → Bridge Pattern
- Text: “must interface to existing set of objects”, “must interface to existing API”, “must interface to existing service” →Façade Pattern
- Text: “complex structure”, “must have variable depth and width” → Composite Pattern
- Text: “must provide a policy independent from the mechanism”, “must allow to change algorithms at runtime” →Strategy Pattern
- Text: “must be location transparent” → Proxy Pattern
- Text: “must be extensible”, “must be scalable” →Observer Pattern (MVC Architectural Pattern)

Software Life Cycle Models

Software life cycle:

- set of activities and their relationships to each other

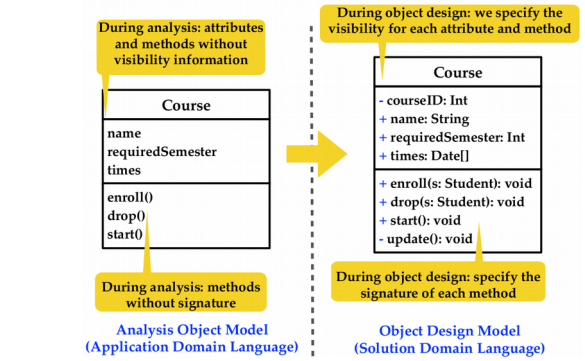
Software life cycle model:

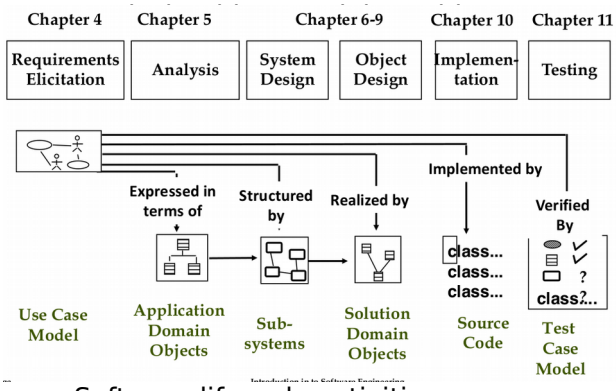
- abstraction representing the development of software

Major Views of Software Life Cycle

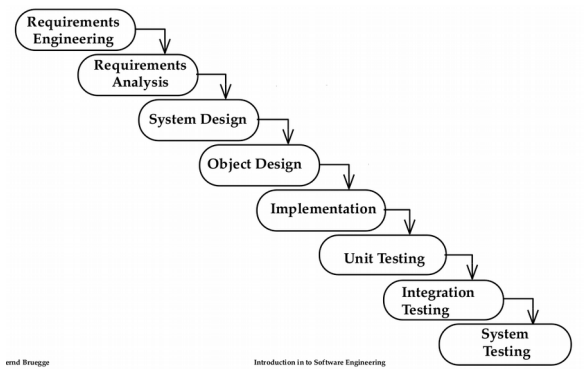
- Activity-oriented view: software dev. Consists of a set of development activities (first: problem definition activity and system dev. Activity, then system operation activity)
- Entity-oriented view: software dev. Consists of the creation of a set of deliverables(market survey, system specification documents, executable system, lessons learned document)

Tailoring: -adjusting a life-cycle model to fit a project(naming, cutting, ordering)





Software lifecycle activities

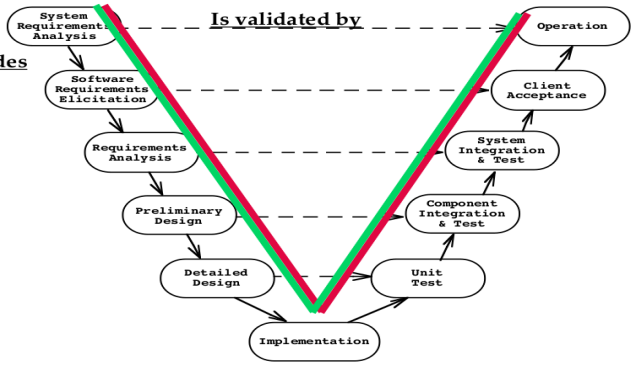


← Waterfall Model (activity diag.)

Properties:
-linear system
-always one activity at a time
-easy to check progress during development

Problems:
-software dev. Is not linear

V-model → precedes

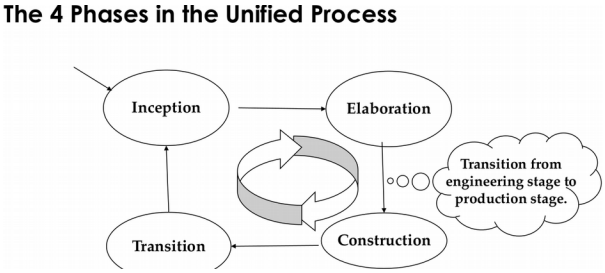


Spiral Model

- iterative model with 4 activities(are applied iteratively in each of 9 rounds)
- **rounds**:(1. Concept of Operations, 2. Software req. , 3. Software Product Design, 4. Detailed design, 5. Code, 6. Unit Test, 7. Integration and Test, 8. Acceptance Test, 9. Implementation)
- each round goes through this activities: 1. Define objects, alternatives, constraints ; 2. Evaluate alternatives, identify and resolve risks; 3. Develop and verify a prototype, 4. Plan the next round

Unified Process

- each cycle consist of 2 **stages** and 4 **phases**
- stages: -Engineering stage(smaller teams,focusing in design activities) with 2 phases(Inception, Elaboration), -Production stage(lager teams, focusing on construction, test and deployment activities) with 2 phases(construction and transition)



Linear and Spiral Model Limitation

- both don't deal with frequent change

Frequency of Change

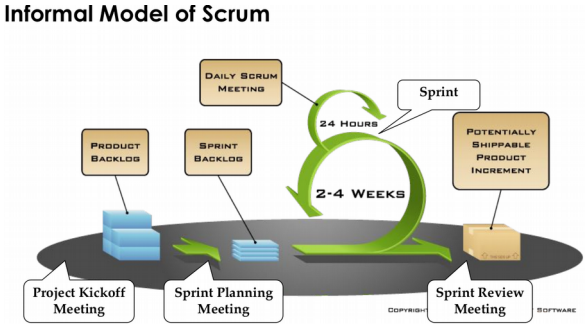
- no change during project → linear model(waterfall, v)
- infrequent changes during project → iterative models (spiral, unified process)
- changes are frequent → agile model (scrum)

Incremental vs Iterative vs Adaptive

Incremental(=add onto something) -improves your process	Iterative(=redo something) -improves your product	Adaptive(=react to changing requirements) -improves the reaction to changing customer needs

Scrum

- Scrum is a technique to manage and control software and product development when the requirements and the technology may be rapidly changing during the project.



Core Components

- 3 Artifacts(Product and Sprint Backlog, PSPI)
- 4 Meeting Activities(Kickoff Meeting, Sprint Planing Meeting: list of prioritized features, Daily Scrum, Sprint Review Meeting)
- 3 Roles(Scrum Master: responsible for process, Product Owner: responsible for product, Developer: responsible for realization of the PSPI)

Scrum Roles

- Scrum Master: -should moderate and coach the team, -main job is to remove impediments[5]
- Product Owner: knows what need to be build and in what order, responsible for product, value and prioritzation
- Scrum Team: 5-6 people, cross-functional (analyst, programmer,designer, tester), team is self-organizing

5 Hindernisse

Software Configuration Management

- Set of management disciplines within a software engineering process to develop a baseline

Configuration Management Activities

- Configuration item identification: modeling the system as a set of evolving components
- Change management: management of change requests (e.g repository architecture)
- Promotion management: creation of versions for other developers
- Branch management: management of concurrent development
- Release management: creation of versions for clients and end users
- Variant management: management of coexisting versions

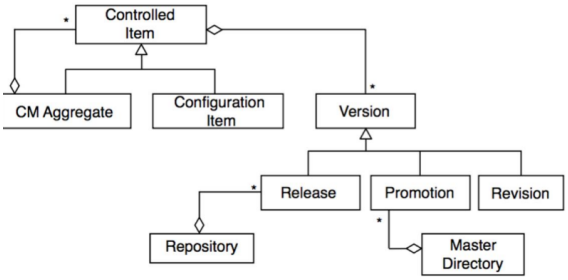


Illustration 3: Object Model for Configuration Management

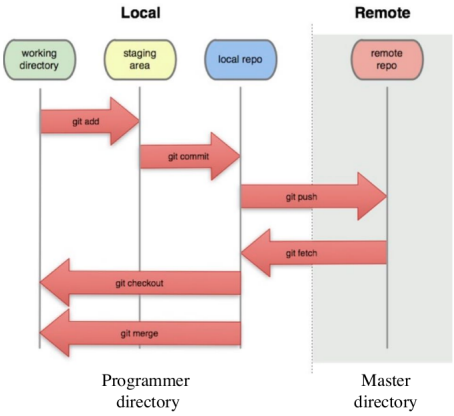
Git

Merge Conflict: happen if two persons work on the same lies in the same file at the same time

Continuous Integration: technique where members of a team integrate their work frequently

Continuous delivery: team keeps producing valuable software in short cycles and ensure that software ca reliable released

Continuous deployment: every change that passes automated test is deploey automatically



Testing