Khulna University
Computer Science & Engineering Discipline

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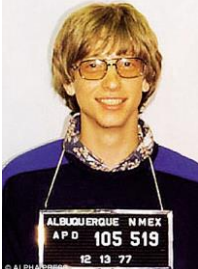
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CSE3203 - Software Engineering and Information System Design

SOFTWARE ENGINEERING

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Chapter 4
Software Process Model

Chapter Outline

- About software process model
- Build and Fix Model
- Why Models are needed?
  - Process as a "black box" & Problem
  - Process as a "white box" & Advantage
- Prescriptive Model
- Waterfall Model or Linear Sequential
- Incremental Process Models
  - Incremental Model
  - RAD Model
- Evolutionary Process Models
  - Prototyping
  - Spiral Model
  - Concurrent Development Model
- Specialized process models
  - Component based development (CBD)
  - The Formal Methods Model
- The Unified Process

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Lecture 5
Software Process Model

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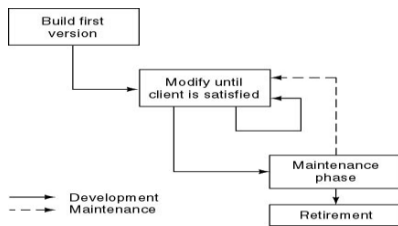

Software process model

- Process models prescribe a distinct set of activities, actions, tasks, milestones, and work products required to engineer high quality software.
- Process models are not perfect, but provide roadmap for software engineering work.
- Software models provide stability, control, and organization to a process that if not managed can easily get out of control
- Software process models are adapted to meet the needs of software engineers and managers for a specific project.

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Build and Fix Model

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Build and Fix Model

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The earlier approach
- Product is constructed without specification or any attempt at design.
- developers simply build a product that is reworked as many times as necessary to satisfy the client.
- model may work for small projects but is totally unsatisfactory for products of any reasonable size.
- Maintenance is high.
- Source of difficulties and deficiencies
  - impossible to predict
  - impossible to manage

Why Models are needed?

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- Symptoms of inadequacy: the software crisis
  - scheduled time and cost exceeded
  - user expectations not met
  - poor quality

Process as a "black box"

Informal Requirements

Process

Product

Quality?

Uncertain / Incomplete requirement In the beginning

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Problems

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- The assumption is that requirements can be fully understood prior to development
- Interaction with the customer occurs only at the beginning (requirements) and end (after delivery)
- Unfortunately the assumption almost never holds

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Process as a "white box"

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Informal Requirements

Process

Product

feedback

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Advantages

- Reduce risks by improving visibility
- Allow project changes as the project progresses
  - based on feedback from the customer

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Prescriptive Model

- Prescriptive process models advocate an orderly approach to software engineering
  - Organize framework activities in a certain order
- Process framework activity with set of software engineering actions.
- Each action in terms of a task set that identifies the work to be accomplished to meet the goals.
- The resultant process model should be adapted to accommodate the nature of the specific project, people doing the work, and the work environment.
- Software engineer choose process framework that includes activities like;
  - Communication
  - Planning
  - Modeling
  - Construction
  - Deployment

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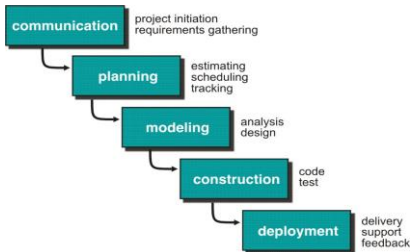
Prescriptive Model

- Calling this model as "Prescribe" because it recommend a set of process elements, activities, action task, work product & quality.
- Each elements are inter related to one another (called workflow).

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Waterfall Model or Classic Life Cycle

Waterfall Model or Classic Life Cycle

- <u>Requirement Analysis and Definition: What</u> - The systems services, constraints and goals are defined by customers with system users.
- <u>Scheduling tracking</u> -
  – Assessing progress against the project plan.
  – Require action to maintain schedule.
- <u>System and Software Design: How</u> –It establishes and overall system architecture. Software design involves fundamental system abstractions and their relationships.
- <u>Integration and system testing:</u> The individual program unit or programs are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer.
- <u>Operation and Maintenance:</u> Normally this is the longest phase of the software life cycle. The system is installed and put into practical use. Maintenance involves correcting errors which were not discovered in earlier stages of the life-cycle.

Limitations of the waterfall model

- The nature of the requirements will not change very much During development; during evolution
- The model implies that you should attempt to complete a given stage before moving on to the next stage
  - Does not account for the fact that requirements constantly change.
  - It also means that customers can not use anything until the entire system is complete.
- The model implies that once the product is finished, everything else is maintenance.
- Surprises at the end are very expensive
- Some teams sit ideal for other teams to finish
- Therefore, this model is only appropriate when the requirements are well-understood and changes will be fairly limited during the design process.
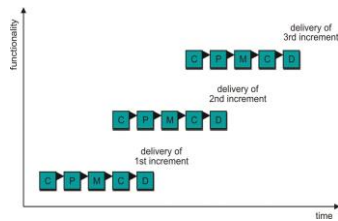
<u>Problems:</u>
- Real projects are rarely follow the sequential model.
- Difficult for the customer to state all the requirement explicitly.
- Assumes patience from customer - working version of program will not available until programs not getting change fully.

Incremental Process Model

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C- Communication
P - Planning
M – Modeling
C - Construction
D - Deployment

Delivers software in small but usable pieces, each piece builds on pieces already delivered

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The Incremental Model

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- Rather than deliver the system as a single delivery, the development and delivery is broken down into increments with each increment delivering part of the required functionality.
- First Increment is often core product
  - Includes basic requirement
  - Many supplementary features (known & unknown) remain undelivered
- A plan of next increment is prepared
  - Modifications of the first increment
  - Additional features of the first increment
- It is particularly useful when enough staffing is not available for the whole project
- Increment can be planned to manage technical risks.
- Incremental model focus more on delivery of operation product with each increment.

The Incremental Model

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- User requirements are prioritised and the highest priority requirements are included in early increments.
- Once the development of an increment is started, the requirements are frozen though requirements for later increments can continue to evolve.
- Customer value can be delivered with each increment so system functionality is available earlier.
- Early increments act as a prototype to help elicit requirements for later increments.
- Lower risk of overall project failure.
- The highest priority system services tend to receive the most testing.

Lecture 6
Software Process Model

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  - RAD Model
- **Evolutionary Process Models**
  - Prototyping
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Rapid Application Development (RAD) Model

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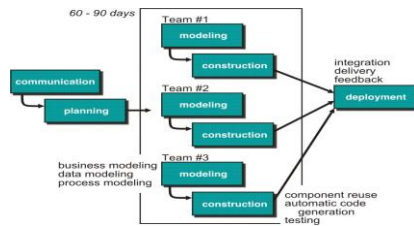
Makes heavy use of reusable software components with an extremely short development cycle

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RAD model

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- **Communication** – to understand business problem.
- **Planning** – multiple s/w teams works in parallel on diff. system.
- **Modeling** –
  - **Business modeling** – Information flow among business is working.
    Ex. What kind of information drives?
       Who is going to generate information?
       From where information comes and goes?
  - **Data modeling** – Information refine into set of data objects that are needed to support business.
  - **Process modeling** – Data object transforms to information flow necessary to implement business.

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RAD model

- **Construction** – it highlighting the use of pre-existing software component.

- **Deployment** – Deliver to customer basis for subsequent iteration.
- RAD model emphasize a short development cycle.
- "High speed" edition of linear sequential model.
- If requirement are well understood and project scope is constrained then it enable development team to create " fully functional system" within a very short time period.

RAD Model

- If application is modularized ("Scalable Scope"), each major function to be completed in less than three months.
- Each major function can be addressed by a separate team and then integrated to form a whole.

Drawback:
- For large but scalable projects
    – RAD requires sufficient human resources
- Projects fail if developers and customers are not committed in a much shortened time-frame
- Problematic if system can not be modularized
- Not appropriate when technical risks are high (heavy use of new technology)

Evolutionary Process Model

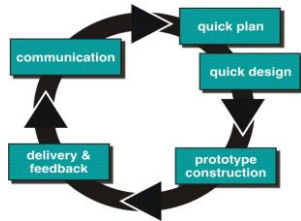- Produce an increasingly more complete version of the software with each iteration.
- Evolutionary Models are iterative.
- Evolutionary models are:
    – Prototyping
    – Spiral Model
    – Concurrent Development Model
    – Fourth Generation Techniques (4GT)

Evolutionary Process Models : Prototyping

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Prototyping cohesive

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- **Best approach when**:
  - Objectives defines by customer are general but does not have details like input, processing, or output requirement.
  - Developer may be unsure of the efficiency of an algorithm, O.S., or the form that human machine interaction should take.
- It can be used as standalone process model.
- Model assist software engineer and customer to better understand what is to be built when requirement are fuzzy.
- Prototyping start with communication, between a customer and software engineer to define overall objective, identify requirements and make a boundary.
- Going ahead, planned quickly and modeling (software layout visible to the customers/end-user) occurs.
- Quick design leads to prototype construction.
- Prototype is deployed and evaluated by the customer/user.
- Feedback from customer/end user will refine requirement and that is how iteration occurs during prototype to satisfy the needs of the customer.

Prototyping (cont..)

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- ☐ Prototype can be serve as "the first system".
- ☐ Both customers and developers like the prototyping paradigm.
  - ■ Customer/End user gets a feel for the actual system
  - ■ Developer get to build something immediately.

Problem Areas:
- ☐ Customer cries foul and demand that "a few fixes" be applied to make the prototype a working product, due to that software quality suffers as a result.
- ☐ Developer often makes implementation in order to get a prototype working quickly without considering other factors in mind like OS, Programming language, etc.
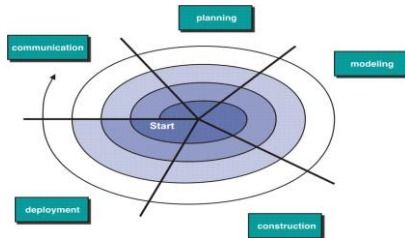
Customer and developer both must be agree that the prototype is built to serve as a mechanism for defining requirement.

Evolutionary Model: Spiral Model

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Spiral Model

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- ❑ Couples iterative nature of prototyping with the controlled and systematic aspects of the linear sequential model
- It provide potential for rapid development of increasingly more complete version of the software.
- Using spiral, software developed in as series of evolutionary release.
  - Early iteration, release might be on paper or prototype.
  - Later iteration, more complete version of software.
- Divided into framework activities (C,P,M,C,D). Each activity represent one segment.
- Evolutionary process begins in a clockwise direction, beginning at the center risk.
- First circuit around the spiral might result in development of a product specification. Subsequently, develop a prototype and then progressively more sophisticated version of software.
- Unlike other process models that end when software is delivered.
- It can be adapted to apply throughout the life of software.

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Spiral Model

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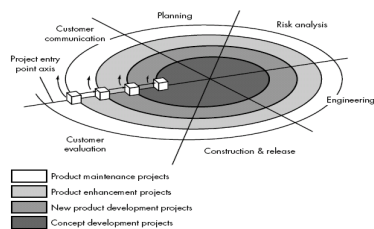
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Spiral Model (cont.)

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Concept Development Project:
- Start at the core and continues for multiple iterations until it is complete.
- If concept is developed into an actual product, the process proceeds outward on the spiral.

New Product Development Project:
- New product will evolve through a number of iterations around the spiral.
- Later, a circuit around spiral might be used to represent a "Product Enhancement Project"

Product Enhancement Project:
- There are times when process is dormant or software team not developing new things but change is initiated, process start at appropriate entry point.

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Spiral Model (cont.)

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- Spiral models uses prototyping as a risk reduction mechanism but, more important, enables the developer to apply the prototyping approach at each stage in the evolution of the product.

- It maintains the systematic stepwise approach suggested by the classic life cycle but also incorporates it into an iterative framework activity.
- If risks cannot be resolved, project is immediately terminated
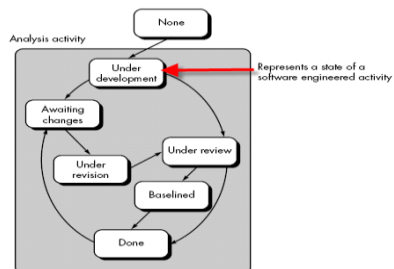
Problem Area:
- It may be difficult to convince customers (particularly in contract situations) that the evolutionary approach is controllable.
- If a major risk is not uncovered and managed, problems will undoubtedly occur.

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Concurrent Development Model

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Concurrent Development Model

- It represented schematically as series of major technical activities, tasks, and their associated states.
- It is often more appropriate for system engineering projects where different engineering teams are involved.
- The activity-modeling may be in any one of the states for a given time.
- All activities exist concurrently but reside in different states.
E.g.
- The *analysis* activity (existed in the **none** state while initial customer communication was completed) now makes a transition into the **under development** state.
- *Analysis* activity moves from the **under development** state into the **awaiting changes** state only if customer indicates changes in requirements.
- Series of event will trigger transition from state to state.
E.g. During initial stage there was inconsistency in design which was uncovered. This will triggers the analysis action from the **Done** state into **Awaiting Changes** state.

Concurrent Development (Cont.)

- Visibility of current state of project
- It define network of activities
- Each activities, actions and tasks on the network exists simultaneously with other activities ,actions and tasks.
- Events generated at one point in the process network trigger transitions among the states.

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Specialized process models

- Component based development—the process to apply when reuse is a development objective
- Formal methods—emphasizes the mathematical specification of requirements
- AOSD—provides a process and methodological approach for defining, specifying, designing, and constructing *aspects*
- Unified Process—a "use-case driven, architecture-centric, iterative and incremental" software process closely aligned with the Unified Modeling Language (UML)

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Component Based Development

- component-based development (CBD) model incorporates many of the characteristics of the spiral model.
- It is evolutionary by nature and iterative approach to create software.
- CBD model creates applications from prepackaged software components (called *classes).
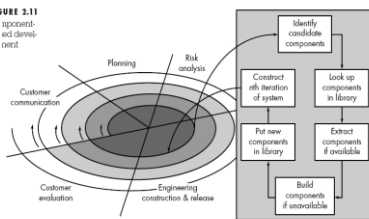
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CBD Model

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CBD model (cont.)

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- Modeling and construction activities begin with identification of candidate components.
- Classes created in past software engineering projects are stored in a class library or repository.
- Once candidate classes are identified, the class library is searched to determine if these classes already exist.
- If class is already available in library extract and reuse it.
- If class is not available in library, it is engineered or developed using object-oriented methods.
- Any new classes built to meet the unique needs of the application.
- Now process flow return to the spiral activity.

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CBD model (cont.)

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- CBD model leads to software reusability.
- Based on studies, CBD model leads to 70 % reduction in development cycle time.
- 84% reduction in project cost.
- Productivity is very high.

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The Formal Methods Model

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- Rigorous mathematical representation of requirements
- Provides basis for automatic verification test generation
- Ambiguity, incompleteness and inconsistency can be discovered and corrected more easily

BUT concern remains about
- Time consuming and expensive
- Extensive training is required
- Non technical customers feel uneasy

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The Unified Process

- a "use-case driven, architecture-centric, iterative and incremental" software process closely aligned with the Unified Modeling Language (UML)

- During the early 1990s James Rambaugh, Grady Booch, and Ivar Jacobson began working on a
" unified process" that would combine the best features of each of the individuals methods and adopt additional features proposed by other experts in the OO fields.
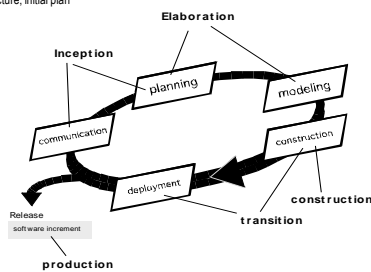
Phases of the Unified Process

Rough architecture, initial plan

Major work products in UP Phases

Class Test 2

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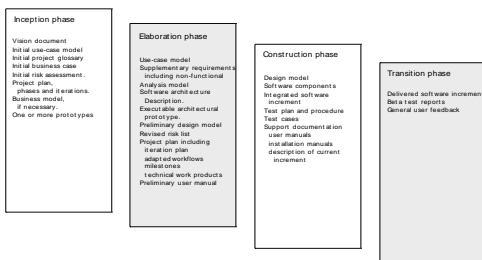
- Chapter 3 and 4
- Total Marks 30
- Total Time 40min
- Will be on Next Class

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